











*Lexicon Technicum :*  
Or, An UNIVERSAL  
**English Dictionary**  
OF  
**ARTS and SCIENCES:**

EXPLAINING

Not only the TERMS of ART, but the  
ARTS Themselves.

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In TWO VOLUMES.

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By *JOHN HARRIS*, D.D. and F. R. S.

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V O L. II.

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Printed for J. WALTHOE, Mess. KNAPTON, D. MIDWINTER,  
A. BETTESWORTH and C. HITCH, E. SYMON, T. WARD  
and E. WICKSTEED, B. MOTTE and C. BATHURST,  
A. WARD, J. CLARK, D. BROWN, T. WOTTON, T.  
HATCHETT and E. COMINS. **MDCCXXXVI.**

# English Dictionary

ART and CRAFTS

Not only the Terms of ART, but also  
the Terms of CRAFT

In Two Volumes

By JOHN WOODWARD, Esq.

The Second Edition

Now revised and enlarged, with many new  
additions, and a new Preface, by  
the Author.



1754

1754

Printed by J. WOODWARD, at the  
Printers, in Pall-mall, near  
St. James's Church, in the  
City of London.



# LEXICON TECHNICUM:

OR, AN

## UNIVERSAL *ENGLISH* DICTIONARY

OF

### Arts and Sciences.

#### J A C

**J**ACK *in a Lanthorn*, a certain Meteor or clammy Vapour in the Air, reflecting Light in the dark, which commonly haunts Churchyards, Fens, Privies; which steams out of a fat Soil. It also flies about Rivers, Hedges, &c. where there is a continual Flux of Air, and leads such Persons as follow it unwarily out of the way.

JACK, in a Ship, is that Flag which is hoisted up at the Sprit-Sail-Top-Mast-Head.

JACOB'S-STAFF, a Mathematical Instrument for taking Heights and Distances; the same with *Cross-staff*; which see.

JACTIVUS, *Fativus*, a Latin Word, signifying in the Law, him that loseth by Default: *Placitum suum neglexerit, & Jactivus exinde remansit.* Formul. Solenn.

JAM, or *Jamb*, is in the Language of our Lead-Miners in *Mendip*, a thick Bed of Stone, which hinders their Work when they are pursuing the Veins of Ore.

IAMBUS, is a Foot of a Latin Verse, consisting of two Syllables, when the first is short, and the other long, as *Tenax*.

JANITOR, the same with *Pylorus*.

JAUNDICE: see *Icterus*.

ICE. In *The Works of the Learned* for July, 1701, there is an Abridgment of a French Book, called *Nouvelle Conjecture pour expliquer la Nature de la Glace*; in which the nameless Author modestly proposes the following Conjectures about Freezing and Ice.

Water freezes only because its Parts lose their natural Motion, and cleave close to one another; but we must observe,

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1. That the Water, whilst it freezes, seems to dilate itself, and that it becomes more light; whereas it should seem that it ought to become more weighty.

2. That frozen Water is not quite so transparent, and that the Bodies transpire not so freely thro' it as formerly; tho' one would think the contrary should happen, if it be true that the Water dilates itself as it freezes. These are the seeming Contrarieties which are found in the Effects and Properties of Ice, that make the Nature of it obscure and difficult to be explained.

'Tis the common Opinion of Philosophers, That Ice is made by certain Spirits of Nitre, which in the Winter mix with the Parts of the Water, and being of themselves improper for Motion, because of their Figure and Inflexibility, enfeeble and destroy gradually that of the Parts to which they are joined. This Opinion is supported by some Experiments, which prove, at least, that on certain Occasions the Spirits of Salt and Nitre contribute to form the Ice.

Our Author has no Design to controvert those Experiments: He says only, That 'tis not certain that the Spirits of Nitre do always enter into the Composition of Ice; and that tho' they enter'd the same constantly, that alone would not be sufficient to explain all the Effects.

For Instance; We cannot conceive how the Spirits of Nitre, which enter the Pores of the Water, and fix the Parts of it, can oblige the Water to dilate itself, and make it more light; whereas naturally they ought to augment the Weight of it. This Difficulty, and some others that might be insisted upon,



upon, shew the Necessity of a new System to explain the Nature of *Ice*: Therefore our Author gives this that follows, which he conceives explains all things with more Ease, and in a more simple manner, than the ordinary System.

He alledges, That Water freezes in the Winter, because its Parts being more closely joined together, they mutually embarrass one another, and lose all the Motion they had; and he supposes the Air to be the sole, or at least the principal Cause, why the Parts of the Water join so closely together. He explains it thus:

There are an infinite Number of small Parts of gross Air mix'd among the Parts of the Water, as every Man may plainly perceive: For if we put into a Pneumatick Machine an open Vessel full of Water, in that same Proportion as you pump the Air out of the Machine, you will see the Water bubble up, and send forth a great Quantity of gross Air.

Those Parts of gross Air being dispersed among those of the Water, they have each of them the Virtue of a Spring; which is now so well proved in Natural Philosophy, that no Man will call it in question.

If then it can be shewed, That the small Springs of gross Air, mixed with the Water, have more Force in the Winter, and that then they unbend themselves a little; it would easily be conceived, that on one side those Springs unbending themselves in that manner, and on the other the external Air continuing to press the Surface of the Water, the Parts of the Water shut up betwixt those small Springs, which repulse them on all sides, must needs, being lock'd up one against another, lose their Moisture, and form a hard Body, that is to say, *Ice*. All the Difficulty lies in this, How to know whether in reality the Springs of the Air, which are dispersed in the Water, unbend a little in the Winter; which 'tis easy to prove they do.

The gross Air, which we cannot perceive in the Water, whilst it is Liquid, is easily seen when 'tis Frozen; we see then very often a great Quantity of Bubbles of Air very sensibly; and when they are too small to be observed every one apart, we may see them confusedly and in gross; for frozen Water is always a little whiter than 'twas before; and they that have studied any thing of the Nature of Colours, know that this Whiteness proceeds only from the small Bubbles of Air mix'd with the *Ice*. This is the Reason that all Scums are whitish, and that the Bubbles of Air mix'd with Glass or Crystal appear whiter than the rest.

Add to this, That the little Bubbles of gross Air, which are absolutely insensible in the Water, so long as 'tis liquid, cannot become sensible in frozen Water, but because each of them becomes grosser than they were: And they cannot become grosser, but for one of these Reasons; either because the Water, when it freezes, hath attracted new Air; or because the Air already dispersed in the Water takes up a greater Space, and that its Springs are a little more unbended. We cannot conceive how the Water, as it freezes, could attract new Air, since the Pores of the *Ice* are certainly less than those of the Water, thro' which the gross Air cannot pass but with Difficulty. It must be then, that the Air already dispersed among the Parts of the Water, is dilated, and that the Springs are a little unbended.

But why, when 'tis cold, have the Springs of the Air more Strength to unbend themselves, than at another Season?

It is answer'd in the first Place, That to establish this System here laid down, it is enough to prove

that the thing happens really so, without any Necessity of explaining the Cause of it.

Secondly, That this Cause is not very difficult to be found. Every one knows that Bodies with Springs have so much more Force as they are more stiff, and that they are so much the more stiff, as their Pores are less; but it is the Property of Cold to restrict the Pores: And during the Heat the Pores are more open, because the subtil Matter which passes always thro' them, being then in a more violent Motion, hath the more Force to extend them and keep them open; whereas in the Winter, their Motion being much slacken'd, all the Bodies shut themselves up, and their Pores are straighten'd. Hence it comes, that in the Winter the Bodies of Animals transpire much less than in another Season. Since then the Cold locks up the least Parts of the gross Air, and makes them less pliable, and more stiff, because it straightens the Pores; we must say also, that it augments the Force of their Springs, the Springs becoming more violent, according as the Body becomes more stiff.

Thus, during the Winter, the Springs of Air which are dispersed in the Water having considerably more Force, they must unbend themselves a little, and as they unbend, they press against one another the small Parts of Water which they hold shut up.

This being supposed, there is nothing in *Ice* but what may be explained naturally enough.

1. That Water, as it freezes, ought to make a hard Body, because then its Parts being pressed one against another, they embarrass one another mutually, and so lose all the Motion they had.

2. That Water, as it freezes, ought to become more light; for tho' its Parts be more press'd than they were before, yet the Mass being composed of the Parts of the Water thus press'd, and of Air dilated, ought to be more large, and by consequence more light, than it was when the Water was liquid.

3. Frozen Water takes up a greater Space than when 'tis liquid, because the Springs of Air dispersed in the Water, by unbending themselves, do oblige the Water to rise in the Vessel which contain'd it. It is true, that the external Air presses also the Surface of the Water, and makes an Effort to repel it; but this external Air being freer, and its little Springs less bended, because they unbended themselves according as the Cold lock'd up the neighbouring Bodies, it hath less Force than that which is shut up, in the Water, whose Springs cannot unbend, but by making the Bulk of the Water larger.

4. If you shut up a Vessel full of Water in the Pneumatick Machine, the Air dispersed in the Water dilates itself in an extraordinary manner when they pump the Air of the Machine; yet the Water freezes not, because the external Surface of the Water being no more press'd, the Air which it contains may, by unbending itself, escape freely, as in reality it does.

5. Frozen Water must always be less transparent than the same Water when it is liquid, because the Bubbles of Air which are insensible in the Water, by reason of their Smallness, being more sensible and large in the *Ice*, must also make it appear to be more white, and by consequence less transparent.

6. The Bodies must much less transpire through the *Ice*, than through the Water, because the Parts of the frozen Water are, in effect, more press'd than they were before, and so leave a less free Passage to foreign Bodies.

7. The



7. The Water, from which there is abundance of Air drawn by means of the Pneumatick Engine, must also freeze with less Difficulty; of which an able Man told our Author he had made the Experiment.

8. The Spirit of Wine, Brandy, and other Liquors of the same sort, cannot freeze at all, or at least rarely; for their Parts being in a great Motion, as appears by the Evaporation made of them, it follows, that the Air dispersed into the Parts of those Liquors, is much more subtil, and by consequence hath less of a Spring, than that which is dispersed in the Parts of common Water, since the Spring of the Air is principally in its gross Parts.

9. Oil, Fat, and other viscous Liquors, must congeal more easily than Water freezes, because their Parts being improper for Motion, do speedily embarrass one another; but those Liquors, when they congeal, cannot become so hard as *Ice*, nor dilate themselves in the same manner; for tho' they contain among their Parts a greater Quantity of Air than Water does, yet that Air is more subtil, hath less Spring, and easily makes its way tho' the Pores of those Liquors.

10. Quicksilver cannot freeze, because it does not contain a great enough Quantity of gross Air; its Parts also are much polish'd, and they can easily slide one against another, without embarrassing or stopping one another.

11. According as the Cold grows more sharp, the Springs of the Air, dispersed in the *Ice*, ought to have more Force to repel the Parts of the frozen Water; and the Bulk composed of the Air and frozen Water, must needs grow larger and larger. This hath been proved in the following manner: They fill'd with Water an hollow Iron Bullet, which had a Hole of three or four Lines Diameter; the Water being frozen in that Bullet, and not being strong enough to break it; the *Ice* issued at the Hole, and form'd a sort of Stalk or Ice-ickle, which lengthened according as the Cold increased, and grew to the Length of a Finger; this Stalk being broke, and the Bullet exposed to the Air during a very cold Night, it made a new Stalk, but not so long as the former, the *Ice's* pining itself, if we may be allowed so to speak, as it passed through the Hole of the Bullet; as Gold and other Minerals do, by passing through the Wire-drawer's Instruments.

12. In the Hypothesis here laid down, the Spirits of Nitre may also contribute to form the *Ice*, in as much as by joining themselves to the small Parts of the Air dispersed in the Water, they contribute towards rendring them more stiff and inflexible, and to augment the Force of its Springs. See *Freezing and Cold*.

ICH DIEN, the Motto under the Arms of the Prince of Wales; which Sir H. Spelman judges to be in Saxon, *Ich Thien*; the Saxon *D*, with a traverse Stroke, being the same with *Th*; and signifies *I Serve*, or *am a Servant*. As the Saxon King's ministerial Lords were called *Thiens*.

ICHNOGRAPHY, in Perspective, is the View of any thing cut off by a Plane parallel to the Horizon, just at the Base or Bottom of it: And in Architecture is taken for the Geometrical Plan or Plat-form of an Edifice, or the Ground-plot of a House or Building delineated upon Paper, describing the Form of the several Apartments, Rooms, Windows, Chimneys, &c. And this is properly the Work of the Master-Architect or Surveyor, being indeed the most abstruse and difficult of any.

ICHNOGRAPHY, in Fortification, is in like manner the Plane or Representation of the Length

and Breadth of a Fortress, the distinct Parts of which are mark'd out either upon the Ground it self, or upon Paper. See *Iconographia*.

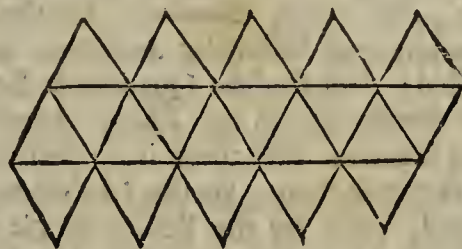
ICHOR, [*ἰχὼρ*, Gr.] is a sulphureous and watery Humour which flows from Ulcers. *Blanchard*.

ICHOROIDES, is a Moisture like Corruption.

ICONOGRAPHIA [*ἑικονογραφία*, of *ἑῖκων* an Image, and *γραφῆ*, Gr. a Description.] A Description of Images, or of the antient Statues of Marble, Copper, Busts, Semi-busts, of Penates, Paintings in Fresco, Mosaick Works, and antique Pieces in Miniature.

ICOSIHEDRON, [*ἑικοσῆδρον*, of *ἑῖκοσι*, twenty, and *ἔδρα*, Gr.] see *Regular Bodies*. This Solid consists of twenty *Triangular Pyramids*, whose Vertexes meet in the Center of a Sphere that is imagined to circumscribe it, and therefore have their Height and Bases equal: Wherefore the Solidity of one of those Pyramids, multiplied by 20, the Number of Bases, gives the solid Content of the *Icosihedron*.

The following Figure being drawn on Pasteboard cut half thro', and then folded up neatly together, will represent an *Icosihedron*.



ICTERICK [*ἰκτερικὸς*, Gr.] of or pertaining to the Jaundice; as *Icteric* Medicines are such as are good against the Jaundice.

ICTERUS, [*ἰκτερ*, Gr.] the Jaundice, is a changing of the Skin into a Yellow Colour, from an Obstruction of the *Ductus Choleodochus*, or the Glandules of the Liver, thro' Weakness, Obstruction, or a *Schirrus* of the Liver; or because the Gall abounds more than can be conveniently excerned, so that it stays in the Blood. The *Latins* call it, *Regius Morbus*, the Kingly Disease, because it is easily cured in Courts with the Pastimes and Diversifements there which chear the Mind. It is also called a Suffusion of the Gall. *Blanchard*.

IDEA, is whatsoever the Mind perceives in it self, or stands there for the immediate Object of any Phantasm, Notion, Species, Thought or Understanding.

IDEA'S. Our Observation employ'd, either about *External Objects*, or about the *Internal Operation* of our Minds, perceived and reflected only by our selves; is that which supplies our Understanding (saith Mr. Locke) with all the Materials of Thinking. These Two are the great Foundations of Knowledge, from whence all the *Idea's*, Notions, Phantasms, Species, &c. which we have, or can naturally have, do spring and arise.

1. Our Senses, being conversant about particular Sensible Objects, do convey into the Mind several distinct Perceptions of Things: And this way we gain the *Idea's* of Yellow, White, Heat, Cold, Soft, Hard, Bitter, Sweet, and all those which we properly call *Sensible Qualities*; and this great Source of most of the *Idea's* we have, depending wholly on our Senses, and derived by them to the Understanding, is called *Sensation*.

2. The other Fountain from which Experience furnishes the Understanding with *Idea's*, is the *Perception of the Operation of our own Minds within us*, as it is employed about the *Idea's* it hath before gotten by *Sensation*: Which *Operations*, when we come to *Reflect* and *Consider* on, our Understanding thereby



thereby becomes furnish'd with another Set of *Idea's*, which could not be had from Things without; and such is *Perception, Thinking, Doubting, Believing, Reasoning, Knowing, Willing, &c.* and all the different Actions of our Minds; which we being conscious of, and observing in our selves, do from these receive into our Understandings, as *distinct Idea's*, as we do from Bodies affecting our Senses. This is a kind of *Internal Sensation*; is called very properly, by Mr. *Locke, Reflection*: And these two, *Sensation* and *Reflection*, he takes to be the only Originals from whence all our *Idea's* take their Beginnings.

And so far the Mind or Understanding is merely *passive*; and cannot chuse whether it will have these Beginnings or Materials of Knowledge or not. The Objects of Sense will obtrude their *Idea's* upon our Minds; and the Operations of our Minds will not let us be without some (at least obscure) Notions of them. No one can be wholly ignorant of what he doth when he Thinks: And as the Mind is forced to receive Impressions from without, so it cannot avoid the Perception of those *Idea's* that are annex'd to them.

Of *Idea's*, some (as we should carefully observe) are *Simple*, and others *Complex*. All those *Idea's* that come into our Minds by *Sensation*, are of the former Kind: And tho' the Qualities in Bodies that affect our Senses, are in the Things themselves, so united and blended, that there is no Separation nor Distance between them; yet the *Idea's* they produce in the Mind, enter by the Senses simple and unmix'd. Some *Idea's* come into our Minds only by *one Sense*, which is peculiarly adapted to receive them: As the *Idea's* of all *Colours* are received only by the Eye, all *Sounds* and *Tones* by the Ear, &c. *Heat, Cold, and Solidity*, by the Touch.

Other *Idea's* we gain by more than one Sense; as of *Space, Extension, Figure, Rest, and Motion*: For these make forcible Impressions both on the Eyes and Touch.

There are other *Simple Idea's*, which convey themselves into the Mind by all the ways of *Sensation* and *Reflection*; as *Pleasure, Pain, Power, Existence, Unity, and Succession*; and these are all, or, at least, the most considerable of those *Simple Idea's* which the Mind hath; and out of which is made all its other Knowledge.

To understand the Nature of these *Simple Idea's* the better, and to discourse of them intelligibly, it will be convenient to distinguish them as they are *Idea's* or *Perceptions* in our Minds, and as they are Modifications in the Bodies that cause such Perceptions in us; that so we may not think (as perhaps is usually done) that they are exactly the *Images* and *Resemblances* of something inherent in the Subject: For most of those of *Sensation* are in the Mind no more the *Likeness* of something existing without us, than the *Names* that stand for them, are the *Likeness* of our *Idea's*. But here the Qualities in Bodies, which produce these *Idea's* in our Minds, must be distinguished into *Primary* and *Secondary*. *Primary Qualities* are such as are utterly inseparable from the Body, in what State soever it be; such as the Sense constantly finds in every Particle of Matter; which are *Solidity, Extension, Figure, Motion, Rest, and Number*. *Secondary Qualities*, are such as are in reality *Nothing* in the Objects themselves, but only Powers to produce various Sensations in us by their *Primary Qualities*; i. e. by the *Bulk, Figure, Texture, and Motion* of their Insensible Parts; as *Colours, Sounds, Tastes, &c.* Now the *Idea's* of *Primary Qualities* are, in some Sense, *Resemblances* of them, and their Patterns do really exist in the Bo-

dies themselves; but the *Idea's* produced in us by these *Secondary Qualities*, have no *Resemblance* of them at all. There is nothing like our *Idea's* existing in the Bodies themselves: They are in the Bodies, we denominate from them only a *Power* to produce those Sensations in us: And what is *Sweet, Blue, or Warm* in *Idea*, is but the certain Bulk, Figure, and Motion of the insensible Parts in the Bodies themselves, which we call so.

There are several Faculties which the Mind hath of managing these *Simple Idea's*, which are very well worth our Observation; as that of *Discerning* duly, and rightly *Distinguishing* one from another: In this consists the Accuracy of Judgment, and the avoiding all Confusions and Mistakes.

2. That of *Comparing* them one with another, in respect of *Extent, Degree, Time, Place*, or any other Circumstances of *Relation* or Dependance one on another.

3. The Faculty of *Compounding* or putting together the *Simple Idea's* receiv'd by *Sensation* or *Reflection*, in order to make *Complex* ones.

4. When Children, by repeated *Sensations*, have got some *Idea's* fix'd in their Memories, they, by degrees, begin to learn the Use of Signs; and when they can speak articulately, they make use of Words to signify their *Idea's* to others: And the use of Words being to stand as outward Marks of our Internal *Idea's*; and those *Idea's* being taken from particular Things, if every particular *Idea* that we take in should have a particular Name, Names must grow endless. To prevent this, the Mind, by

5. Another Faculty, can make the particular *Idea's* received from such Objects, to become *General*: Which is done by considering them as they are in the Mind such Appearances, separate from all other Existences, and the Circumstances of real Existence; such as *Time, Place*, or any other concomitant *Idea's*; and this is called *Abstraction*; whereby *Idea's* taken from particular Things, become general Representatives of all of that kind; and their *Names*, general Names applicable to whatever exists conformable to such *Abstract Idea's*. Thus the same Colour being observ'd to Day in Chalk or Snow, which the Mind Yesterday received from Milk or Cerusse; it considers that Appearance alone; makes it a Representative of all of that kind; and having given it the Name of *Whiteness*, it by that Sound signifies the same Quality wheresoever to be met with or imagined. And thus *Universals*, whether *Idea's* or *Terms*, are made.

From the Power which the Mind hath of *combining* thus, *comparing*, and *separating* or *abstracting* its *Simple Idea's*, which come into it by *Sensation* and *Reflection*, all *Complex Idea's* are form'd; and, as before in the Perception of *Idea's*, the Understanding was *passive*, so here 'tis *active*; exerting the Power it hath in the several Acts and Faculties above-mentioned, in order to frame *Compounded Idea's*.

All *Complex Idea's*, tho' their Number be infinite, and Variety endless, may be, as it seems, all reduced to these three Heads, viz. *Modes, Substances* and *Relations*.

*Modes* are such *Complex Idea's*, which however compounded, are not supposed to exist by themselves, but are consider'd as *Dependencies on*, or *Affections* of Substances: Such are the *Idea's* signified by the Words *Triangle, Gratitude, Murder, &c.* and these *Modes*, as Mr. *Locke* calls them, are of two Sorts.

1. Such as are only Variations, or different Combinations of the same *Simple Idea*, without the Mixture of any other; as a *Dozen, a Score, &c.* and these may be called *Simple Modes*.

2. There



2. There are others compounded of *Simple Idea's* of several Kinds put together, to make one Complex one; as *Beauty, Theft, &c.*

*Substances* have their *Idea's*, such Combinations of *Simple Idea's*, as are taken to represent distinct particular Things subsisting by themselves; in which the supposed, or confused *Idea* of Substance, such as it is, is always the First and Chief.

*Relations*, are a sort of *Complex Idea's* arising from the Consideration and Comparison of one *Idea* with another. Of these, some depend only on the Equality or Excess of the same *Simple Idea* in several Subjects; and these Mr. *Locke* thinks may be called *Proportional Relations*; such as *equal, more, bigger, sweeter, &c.* Another Occasion of comparing Things together, is the Circumstances of their Origin or Beginning; and this being not afterwards to be altered, make the *Relations* depending thereon as lasting as the Subjects to which they belong: These are *Natural Relations*, such as *Father, Brother, Uncle, Cousins, &c.* There are also *Relations* by *Institution*, as *Prince and People, General and Army, &c.* *Moral Relations*, are the Conformity or Disagreement of Men's free Actions to Laws and Rules, whether *Divine* or *Human*.

It may be considered also further about our *Idea's*, that some are *clear* and *distinct*, others *obscure* and *confused*. Our *Simple Idea's* are *clear*, when they continue such as the Objects represent them to us, when our Organs of Sensation are in a good Tone and Order; when our Memories *retain* them, and can produce and present them to the Mind whenever it hath occasion to consider them: And if along with this the Mind sees that these *Simple Idea's* are severally different one from another, and each single one from all the rest, then they are distinct also as well as clear: And the contrary to this will occasion *Obscurity* and *Confusion*.

IDENTITATE NOMINIS, is a Writ that lies for him, who, upon a *Capias* or *Exigent*, is taken and committed to Prison for another Man of the Name.

IDENTITY: The *Idea's* of *Identity* and *Diversity*, come into our Minds by the Power it hath of comparing the very *Beings* of Things; whereby considering any thing, as existing in any determined Time and Place, we compare it with it self existing at another time; and accordingly pronounce it to be the *same* or *diverse*. When we see any thing to be in any Place in any *Instant* of Time, we are sure (be the thing what it will) that it is *that very thing*, and not another: For whatever is *another* thing, must at that same time exist in another Place, how like soever it may be in all other Respects. And in this consists *Identity*; when the *Idea's* it is attributed to, vary not at all from what they were that moment, wherein we consider'd their *former* Existence, and to which we compare the *present*: for never finding nor conceiving it possible, that two things of the same Kind should exist in the same Place at the same Time, we rightly conclude, that whatever exists any where at any time, excludes all of the same Kind, and is there itself alone. When therefore we demand, Whether any thing be the *same*, or not? It always refers to some thing that existed at such a Time in such a Place, which, 'twas certain, at that Instant, was the same with it self and no other. From whence it follows, that *one thing* can't have *two Beginnings* of Existence, nor *two things one*; it being impossible for two things of the same Kind, to be or exist in the same Instant, in the very same Place; or one and the same thing in divers Places. Whatever therefore had *one Beginning*, is the same thing; and that

which had a different Beginning in Time and Place from *that*, is not the same with that, but different from it.

We seem to have *Idea's* but of three sorts of Substances, *GOD, Finite Intelligences* or *Spirits*, and *Bodies*. Of *GOD*, 'tis demonstrable that He is without Beginning, Eternal, Unalterable, and Omnipresent; wherefore of His *Identity* there can be no doubt.

*Finite Spirits* having had each its determinate Time and Place of Beginning to *exist*, the Relation to that Time and Place, will always determine to each of them its *Identity*, as long as it *exists*.

And the same will hold of *Bodies*: And in every Particle of Matter, to which no Addition or Subtraction of Matter being made, it is the same. And though these three sorts of Substances do not exclude *one another* out of the same Place, yet we cannot conceive but that they must necessarily *each* of them exclude *any other of the same Kind*, out of the same Place; or else the Notions and Names of *Identity* and *Diversity* would be in vain; and there could be no such Distinction of Substances, or any thing else from one another. Thus, *v. gr.* if two Bodies or Particles of Matter could be in the same Place at the same Time; then take them, great or little, they must be *one* and the *same*; nay, thus all Bodies must be one and the same.

'Tis plain then that the so much disputed *Principium Individuationis*, is Existence itself; which determines a Being of any sort to a particular Time and Place, incommunicable to two Beings of the same Kind.

And here it will do well to distinguish between dead and unactive Lumps of Matter, and such Bodies as those endow'd with Vegetable or Animal Life. If you consider one of the former Kinds of Bodies; if it consist only of *one*, or a determinate Number of many Atoms, any way combined together; while that *one* continues without Mixture with others; or while the *many exist*, united together in the same Mass, it will still be the same Body; but if one Atom be taken away, or any new one added, it is no longer the same Mass, or the same Body. But in the State of Living Creatures, their *Identity* depends not on a Mass of the same *Particles*, but on something else; for in them the Variation of great Parcels of Matter alters not the *Identity*. An Oak growing from a Plant to a great Tree; and a Child growing to an adult Person, are still the same; tho' in both Cases there be a manifest Change of Parts: For here 'tis such a peculiar Disposition and Organization of Parts in one coherent Body, and partaking of one common Life, that constitutes their *Identity*; and as long as that continues, it will be the same Oak or Man. And so it is in a Watch; as long as the Mechanism of it continues the same, and it goes and answers the End of its Organization, 'tis the same Watch, tho' many Particles of Matter continually rub off and wear away. 'Tis clear therefore wherein consists the *Identity* of any Animal or Vegetable.

But there is another sort of *Identity*, which hath not been improperly called *Personal*; which I think Mr. *Locke* truly determines to consist in the *Sameness of a Rational Being*: Since by *Person* we understand an Intelligent Being, having Reason and Reflection: And since there is a *Consciousness* which always accompanies Thinking; it is that which makes every one to be that which he calls *himself*, thereby distinguishing him from all other Beings that think, and give him his *Personal Identity*. See *Essay of Human Understanding*, Book 2. Ch. 27.



**IDEOTA** *inquirenda vel examinanda*, is a Writ to the Escheator or Sheriff of any County, where the King hath Notice that there is an *Ideot*, naturally born so weak of Understanding, that he cannot govern or manage his Inheritance, to call before him the Party suspected of the *Ideocy*, and examine him; and also by the Oath of Twelve Men, to enquire whether he be sufficiently witted to dispose of his own Lands with Discretion, or not, and to certify accordingly into the Chancery: For the King hath the Protection of his Subjects, and by his Prerogative, the Government of their Lands and Substance, that are naturally defective in their own Discretion.

**IDES** of a Month, among the Romans, were the Day after the Nones were out. They commonly fell out on the 13th of every Month, except in *March, May, July, and October* (which they called the *Full Months*, as all the others were called *Hollow*) for then they were on the 15th, because in those Months the Nones were on the 7th. The Etymology of the Word is variously given, and to be seen in most Dictionaries. See *Danet's Greek and Roman Antiquities*.

**IDIOCRASY**, [*ἰδιοκρασία*, of *ἰδίῳ* proper, and *κράσις*, Gr. *Temperature*] the proper Disposition or Temperament of a Thing or Body.

**IDIOPATHY**, [*ἰδιοπάθεια*, of *ἰδίῳ* and *πάθος*, Gr. *affectus*] is a primary Disease, which neither depends on, nor proceeds from any other.

**IDIOSYNCRASY**, [*ἰδιοσυγκράσις*, of *ἰδίῳ*, *σύν* with, and *κράσις*, Gr.] is a Temperament peculiar to any particular Animal Body; whereby it hath, either in Sickness or in Health, a peculiar Aversion against, or Inclination for some particular Things; or on which some Things will have no such, or a more than usual Operation, than they will have on other Bodies.

**JEAT**, a kind of mineral or fossil Stone, found in some of the Northern Parts of *England* and elsewhere, form'd of a lapidifick or bituminous Juice in the Earth in the manner of Coal. It is extremely black, works like Amber, and has most of its Qualities.

**JECTIGATION**, [in *Medicine*] a Trembling or Palpitation felt in the Pulse of a sick Person, which indicates that the Brain, which is the Origin of the Nerves, is attack'd and threaten'd with Convulsions.

**JECUR**, the same with *Hepar*.

**JECUR Uterinum**: see *Placenta Uteri*.

**JEER-CAPSTAN**: see *Capstan*.

**JEER**, or *Jeer-Rope*, is a Piece of a Hawser fastened to the Main-yard and Fore-yard (in great Ships only) close to the Ties; then 'tis reeved thro' a Block, which is seized close to the Top, and so comes down again, and is reeved through another Block at the Bottom of the Mast close by the Deck: There are usually two of these, one on each side the Ties. Its Use is to help hoise up the Yard, but more especially to succour the Ties, and to keep the Yard from falling, if they should break.

**JEJUNUM Intestinum**, is the second of the Small Guts, so called, because it is most times found empty. 'Tis in Length about eight Foot in Men; it begins on the Right Side under the *Colon*, where the *Duodenum* ends, and fills a good Part of the Umbilical Region, especially on the Left Side; 'tis continued to the *Ileum*, but is easily known from it by its Emptiness, by the great Number of its Veins and Arteries, which make it look a little reddish, and also because the Wrinkles in its Coats are more in Number, and nearer to one another, than those in the *Ileum*, and the Coats themselves are much thicker.

**JEOFAIL**, in Common Law, signifies an Oversight in pleading, touching which you have a Statute, 32 H. 8. 30. whereby it is enacted, That if the Jury have once past upon the Issue, tho' afterward there be found a *Jeofail* in the Pleading, yet Judgment shall likewise be given, according to the Verdict of the Jury.

**JESSANT**, when in a Coat of Arms a Lion or other Beast is born over some Ordinary, as over a Chief, a Bend, a Fesse, &c. that Lion or Beast is blazon'd *Jessant* or *Facent*, i. e. lying over all.

**JET D'EAU**, is the French Word for a Pipe of a Fountain, which casts up the Water any considerable Height into the Air.

Mr. Mariotte, in his *Treatise du Mouvement des Eaux*, &c. saith, That a *Jet d'Eau* will never rise so high as its Reservatory, but always falls short of it by a Space; which is in a subduplicate Ratio of that Height; and this he proves by several Experiments.

He saith also, That if a greater branches out into many smaller ones, distributed to different Jets, the Square of the Diameter of the main Pipe must be proportioned to the Sum of all the Expences of its Branches; and particularly saith, That if the Reservatory be 52 Foot high, and the *Adjutage* half an Inch in Diameter, the Pipe ought to be 3 Inches in Diameter. See *Fountain*.

**JET**. Experience has shewn, that to make Water spout 30 Foot high, the Height of the Reservoir ought to be 33 Foot.

Experiments have also determined the Proportion in which this Difference between the Height of the *Jet*, and of the Reservoir, grows greater or less, as the *Jet* is higher or lower. The way of finding it is this: Divide the Height of the *Jet* whose Height of Reservoir is required, by the Height of the *Jet* whose Height of Reservoir is known; square the Quotient, and multiply the said Square of the Quotient by the Difference between the Height of the *Jet* whose Height of Reservoir is known, and the Height of its Reservoir. The Product of this Multiplication will give the Difference between the Height of the *Jet* whose Height of the Reservoir is required, and the said required Height of the Reservoir; which Height being added to the Height of the *Jet* whose Height of Reservoir is required, gives the required Height of Reservoir.

According to this Rule, if it be required to find the Height of a Reservoir necessary to make a *Jet* of any given Height, we may find it by the before-mention'd Proportion of 30 to 33. As for Example, if we want to know the Height of a Reservoir necessary to make a *Jet* of 60 Foot, we divide 60 by 30; then multiply 4 (the Square of the Quotient 2 :) by 3, to wit, by the Difference between 30 and 33; and the Product 12 being added to 60, gives 72, which is the required Height of the Reservoir.

Other Examples will make it more and more clear.

If it be required to find what must be the Height of a Reservoir to make a *Jet* of 90 Foot,  $30 \mid 90 \quad 3 \times 9 = 27, + 90 = 117$  the required Height.

If it be required what must be the Height of a Reservoir, to make a *Jet* of 5 Foot,  $30 \mid 5 \quad \frac{5}{30} = \frac{1}{6}, \times \frac{1}{6} = \frac{1}{36} \times 3 = \frac{1}{12} + 5 = 5$  Foot and 1 Inch.

The same may be done by taking any other Proportion instead of this of 30 to 33. As for Example, if the Proportion of 5 Foot to 5 Foot and 1 Inch be known, and it be required to find the Height of a Reservoir to make a *Jet* of 90; then  $5 \mid 90 \quad 18 \times 18 = 324, \times \frac{1}{12} = 27, + 90 = 117$ , as before. After this manner the following Table was calculated.

A TABLE



A TABLE of the Heights of Reservoirs required to make  
*Jets* of all Heights from 5 Foot to 100, and then of 100,  
 120, 130, 140, 150 Feet.

Jet Feet	Reservoir Feet	Inches	Jet Feet	Reservoir Feet	Inch.	Jet Feet	Reservoir Feet	Inch.	Jet Feet	Reservoir Feet	Inch.
5	5	1	29	31	9 $\frac{1}{2}$	52	61	0 $\frac{4}{5}$	77	96	9 $\frac{4}{5}$
6	6	1 $\frac{1}{5}$	30	33	2 $\frac{1}{5}$	53	62	4 $\frac{9}{5}$	78	93	3 $\frac{9}{5}$
7	7	1 $\frac{2}{5}$	31	34	2 $\frac{2}{5}$	54	63	10 $\frac{1}{5}$	79	99	9 $\frac{1}{5}$
8	8	2 $\frac{1}{5}$	32	35	4 $\frac{1}{5}$	55	65	1	80	101	4
9	9	3 $\frac{1}{5}$	33	36	7 $\frac{1}{5}$	56	66	5 $\frac{1}{5}$	81	102	10 $\frac{1}{5}$
10	10	4 $\frac{1}{5}$	34	37	10 $\frac{1}{5}$	57	67	9 $\frac{2}{5}$	82	104	4 $\frac{2}{5}$
11	11	4 $\frac{2}{5}$	35	39	1	58	69	1 $\frac{2}{5}$	83	105	11 $\frac{1}{5}$
12	12	5 $\frac{1}{5}$	36	40	3 $\frac{1}{5}$	59	70	7 $\frac{6}{5}$	84	107	6 $\frac{6}{5}$
13	13	6 $\frac{1}{5}$	37	41	6 $\frac{1}{5}$	60	72	4 $\frac{2}{5}$	85	109	1
14	14	7 $\frac{1}{5}$	38	42	10 $\frac{1}{5}$	61	73	9 $\frac{1}{5}$	86	110	7 $\frac{1}{5}$
15	15	9	39	44	0 $\frac{1}{5}$	62	74	9 $\frac{2}{5}$	87	112	2 $\frac{1}{5}$
16	16	10 $\frac{1}{5}$	40	45	4	63	76	2 $\frac{1}{5}$	88	113	9 $\frac{1}{5}$
17	17	11 $\frac{1}{5}$	41	46	7 $\frac{1}{5}$	64	77	7 $\frac{1}{5}$	90	117	
18	19	0 $\frac{1}{5}$	42	47	10 $\frac{1}{5}$	65	79	1	91	118	7 $\frac{6}{5}$
19	20	2 $\frac{1}{5}$	43	49	2 $\frac{1}{5}$	66	80	6 $\frac{1}{5}$	92	120	2 $\frac{1}{5}$
20	21	4	44	50	5 $\frac{1}{5}$	67	81	11 $\frac{1}{5}$	93	121	9 $\frac{1}{5}$
21	22	5 $\frac{1}{5}$	45	51	9	68	83	4 $\frac{2}{5}$	94	123	5 $\frac{1}{5}$
22	23	7 $\frac{1}{5}$	46	53	0 $\frac{1}{5}$	69	84	10 $\frac{1}{5}$	95	125	1
23	24	9 $\frac{1}{5}$	47	54	4 $\frac{1}{5}$	70	86	4	97	128	4 $\frac{9}{5}$
24	25	11 $\frac{1}{5}$	48	55	7 $\frac{1}{5}$	71	87	9 $\frac{1}{5}$	98	130	0 $\frac{4}{5}$
25	27	1	49	57	0 $\frac{1}{5}$	72	89	3 $\frac{1}{5}$	99	131	8 $\frac{1}{5}$
26	28	3 $\frac{1}{5}$	50	58	4	74	92	3 $\frac{1}{5}$	100	133	4
27	29	5 $\frac{1}{5}$	51	59	8 $\frac{1}{5}$	75	93	9	130	186	4
28	30	7 $\frac{1}{5}$				76	95	3 $\frac{1}{5}$	140	205	4
									150	225	

Accordingly, to the same Rule, if the Height of any Reservoir being given, the Height of the Reservoir which it will produce may be found: In order to do this in the most general manner, let us call

$a$  = the known Height of the *Jet*, whose Height of Reservoir is known.

$b$  = the known Height of its Reservoir.

$c$  = the known Height of the Reservoir, whose Height of *Jet* is required.

$x$  = the required Height of its *Jet*.

Then by the afore-mentioned Rule,  $\frac{x}{a} q = \frac{x^2}{a^2}$

$$x b - a = \frac{b x^2 - a x^2}{a^2} = c - x.$$

$b x^2 - a x^2 = a^2 c - a^2 x$  freeing it from the Fraction.

$b x^2 - a x^2 + a^2 x = a^2 c$  by Transposition.

$x^2 + \frac{a^2}{b-a} x = \frac{a^2 c}{b-a}$  dividing by  $b-a$ .

$$x^2 + \frac{a^2}{b-a} x + \frac{a^4}{4 b^2 + 8 a b + 4 a^2} = \frac{a^2 c}{b-a} + \frac{a^4}{4 b^2 + 8 a b + 4 a^2}, \text{ completing the Square.}$$

$x + \frac{a^2}{2 b - 2 a} = \sqrt{\frac{a^2 c}{b-a} + \frac{a^4}{4 b^2 + 8 a b + 4 a^2}}$ , extracting the Root.

$$x = \sqrt{\frac{a^2 c}{b-a} + \frac{a^4}{4 b^2 + 8 a b + 4 a^2}} - \frac{a^2}{2 b - 2 a}, \text{ by Transposition.}$$

This Equation always gives the Value of  $x$ , it is the required Height of the *Jet*, compared with the Height of its Reservoir, and any other Proportion of Reservoirs and *Jets* which can be given. As for Example:

If the Proportion of 33 to 30 were given, and it were required to find the Height of a *Jet* whose Reservoir is 72 Foot high; then making  $x$  = to the said required Height, we shall have,

$$\frac{x}{30} q = \frac{x^2}{900}, \times 3 = \frac{3 x^2}{900} = 72 - x, \text{ by the afore-mentioned Rule.}$$

$3 x^2 + 900 x = 64800$ , freeing it from the Fraction and Transposing.

$x^2 + 300 x = 21600$ , by Division.

$x^2 + 300 x + 22500 = 44100$ , completing the Square.

$x + 150 = 210$ , extracting the Root.

$x = 210 - 150 = 60$ , by Transposition.

Therefore the required Height of the *Jet* is 60 Foot.

The readiest Way of calculating Tables of the Heights of *Jets* after this Method, is always to use the Proportion of 33 to 30; and then making

$a$  = any given Height of a Reservoir,

$x$  = the required Height of its *Jet*,

We shall have  $\frac{x}{30} q = \frac{x^2}{900}, \times 3 = \frac{3 x^2}{900} = a - x$ , by the afore-mentioned Rule.

$3 x^2 = 900 a - 900 x$ , freeing it from the Fraction.

$x^2 + 300 x = 300 a$ , by Division and Transposition.

$x^2 + 300 x + 22500 = 300 a + 22500$ , completing the Square.

$x + 150 = \sqrt{300 a + 22500}$ ; whence  $x = \sqrt{300 a + 22500} - 150$ , by Transposition.

This Equation gives the Value of  $x$ , compared with known Quantities; amongst which there is but  $a$  who changes according to the several Cases to which it is applied.



A TABLE of all the Heights of Jets which will be produced by Reservoirs of all Heights, from 5 Foot to 100; and then of 120, 130, 140, 150 Foot.

Ref.	Jets.	Ref.	Jets.	Ref.	Jets.	Ref.	Jets.	Ref.	Jets.
5	4,91	24	22,33	43	38,14	62	52,73	81	66,33
6	5,88	25	23, 2	44	38,93	63	53,47	82	67,02
7	6,84	26	24,06	45	39,75	64	54, 2	83	67,71
8	7, 8	27	24,92	46	40,53	65	54,93	84	68, 4
9	8,74	28	25,78	47	41,37	66	55,65	85	69,76
10	9,68	29	26,63	48	42,09	67	56,39	86	69,08
11	10,62	30	27,48	49	42,87	68	57,12	87	70,47
12	11,55	31	28,32	50	43,65	69	57,84	88	71,14
13	12,48	32	29,16	51	44,42	70	58,56	89	71,81
14	13, 4	33	30,	52	45,19	71	59,28	90	72,48
15	14,31	34	30,83	53	46,72	72	60,	91	73,15
16	15,22	35	31,65	54	47,48	73	60,71	92	73,82
17	16,13	36	32,47	55	47,48	74	61,42	93	74,49
18	17,03	37	33,29	56	48,24	75	62,13	94	75,16
19	17,93	38	34,11	57	48,99	76	62,84	95	75,83
20	18,82	39	34,93	58	49,74	77	63,54	96	76,49
21	19, 7	40	35,74	59	50,49	78	64,24	97	77,15
22	20,58	41	36,55	60	51,24	79	64,94	98	77,81
23	21,46	42	37,75	61	51,99	80	65,64	99	78,47

JETSON: see in *Flotson*.

JEWISH Hours, are the 24 Hours of the Day, accounted from Sun-setting to Sun-setting again, much after the manner as the *Italians* do now.

IGNIS-FATUUS, is a certain Meteor that appears chiefly in the Summer-Nights, for the most part frequenting Church-yards, Meadows and Bogs, as consisting of a somewhat viscous Substance, or a fat Exhalation; which being kindled in the Air, reflects a kind of thin Flame in the Dark, yet without any sensible Heat, often flying about Rivers, Hedges, &c. because it meets with a Flux of Air in those Places. This Meteor is well known among the common People, under the Name of *Will-of-the Whisp*, or *Jack-with-a-Lanthorn*.

IGNIS PERSICUS, the same that *Gangræna*: it is taken also for a Carbuncle.

IGNIS ROTÆ: see *Wheel-fire*.

IGNIS SACER, the same that *Erysipelas*: Yet some take it for an *Herpes*.

IGNIS SYLVESTRIS, the same that *Phlyctena*.

IGNITION [in *Chymistry*] a Term used of the Application of Fire to Metals, till they become red hot without melting; which happens chiefly in *Iron*, and also *Gold* and *Silver*; but not in *Lead* and *Tin*, they being too soft and fusible to bear *Ignition*.

IGNORAMUS, in Law, is a Word used by the Grand Inquest, impanelled in the Inquisition of Causes Criminal and Publick, and written upon the Bill when they dislike their Evidence, as defective or too weak to make good the Presentment: The Effect of which Word so written is, That all farther Enquiry upon that Party, for that Fault, is thereby stopped, and he delivered without farther Answer.

IKEMILDESTREET, one of the four old Roman Ways in England: See *Watling-street*. It was called *Stratum Icenorum*, because it took its Beginning from the *Iceni*, which were those that inhabited *Suffolk*, *Norfolk*, and *Cambridgeshire*.

ILE, is the Cavity from the *Thorax* to the Bones of the Thighs: *Pliny* observes, That all the Intestines in all Animals, except a Man and a Sheep, are called *Ile*. *Blanchard*.

ILEUM, is the Third of the small Guts, so called ἀπὸ τῆς εἰλεῖναι, à *Circumvolvendo*, because of its many Turnings, &c. It begins where the *Jejunum*

ends, and ends it self at the Gut called *Cæcum*, at the Beginning of the *Colon*: It is about 21 Hands Breadth in Length: There can be no such thing as twisting of the Guts, but sometimes the Coats being doubled inward, the upper Part of an Intestine sinks or falls with the lower, which makes the *Iliack Passion*, or *Volvulus*. The *Ileum* oft falls down into the *Scrotum*, and then the Rupture is called *Intestinalis*. The Passage of the *Ileum* is a little narrower than that of the *Jejunum*, and its Coats are somewhat thinner.

ILIA, the *Flanks* are the lateral Parts of the *Abdomen*, betwixt the last Rib and the Secret Parts.

ILIACK PASSION, the same with *Miserere*, or the twisting of the Guts.

ILIACK VESSELS, are those double-forked Vessels of the Trunks of the great Artery, and the great Vein of the *Abdomen*, about the Place where the Bladder and the Womb are situate. *Blanchard*.

ILIACUS EXTERNUS [in *Anatomy*] is a Muscle of the Thigh, arising from the internal Concave Part of the *Os Sacrum* towards the bottom, and descending obliquely along the great *Sinus* of the *Os Ilium*, from a round fleshy Origin, joins the *Glutæus Medius*, and is inserted by a round Tendon at the bottom of the great Trochanter.

ILIACUS INTERNUS, is a Muscle of the Thigh, which arises fleshy from above half the superior Region, and Internal Concave Part of the *Os Ilium*; and in its Descent over the Inferior Part of the last-named Bone, joins with the *Psoas Magnus*, and is inserted with it, partly under the Termination of the *Pectineus*: This, together with the *Psoas Magnus*, move the Thigh forwards in Progression.

ILINGUS: see *Scotomia*.

ILIUM OS, is the first and upper Part of the Bone called *Ossa Innominata*, which are two large Bones situated on the sides of the *Os Sacrum*. This Part of it, *Ilium*, is so named, because it contains the Gut *Ilium*, which lies between it and its Fellow. Its Circumference is circular, being a little convex and uneven on its external side. 'Tis a large Bone, and is connected to the sides of the three superior *Vertebræ* of the *Os Sacrum*: The upper Part of it, of its Edge or Circumference, is called *Spina*, the Concave Internal side *Costa*, and the External Con-



vex one *Dorsum*: It is joined to the *Os Sacrum* by a true *Suture*: It is larger in Women than Men.

ILLUMINATION [in *Physicks*] the Act of a luminous Body which emits Light; also the Passion of an Opaque Body that receives it.

ILLEVIABLE, is what cannot or may not be levied: And therefore *Nihil* is a Word set upon a Debt that is *illeviable*.

ILLUMINATIVE-MONTH, is that Space of Time that the Moon is visible to be seen betwixt one Conjunction and another.

IMAGE, in Opticks, is the Projection of an Object in the distinct Base of a Convex-glass.

To find the Diameter of an Image, in the distinct Base of a Convex-Glass, Mr. Molyneux gives this Rule.

As the Distance of the Object from the Glass:  
To the Distance of the Image from the Glass::  
So the Diameter of the Object's Magnitude:  
To the Diameter of the Image.

Wherefore, if the Diameter of the Sun subtend an Arch of 32 Minutes of a great Circle in the Heavens, the Diameter of the Sun's Image represented in the distinct Base of a Convex-glass, subtends an Arch of 32 Minutes also of such a Circle as hath for its Radius the Distance of the distinct Base from the Glass.

IMAGINATION, is an Application of the Mind to the Phantasm or Image of some Corporeal Thing impressed in the Brain.

IMBRICATED, is a Word used by Mr. Tournefort, and some other Botanists, to express the Figure of the Leaves of some Plants, which are hollowed in like an *Imbrex* or Guttur-Tile.

IMMENSE, is that whose Amplitude or Extension no finite Measure whatsoever, or how oft soever repeated, can equal.

IMMERSION, in *Astronomy*, is when a Star or Planet is so near the Sun with regard to our Observations, that we cannot see it, being as it were envelop'd and hid in the Rays of that Luminary. *Immersion* is also the Beginning of an Eclipse of the Moon; that is, the Moment, when the Moon begins to be darken'd, and to enter into the Shadow of the Earth. And the same Term is used with regard to an Eclipse of the Sun, when the Disk of the Moon begins to cover it. *Emerision* is the Term opposite to *Immersion*, and signifies the Moment, wherein the Moon begins to come out of the Shadow of the Earth; or the Sun begins to shew the Parts of his Disk, which were hid before. *Immersion* is frequently applied to the Satellites of *Jupiter*, and especially to the first Satellite; the Observation whereof is of so much Use for discovering the Longitude. The *Immersion* of that Satellite is the Moment in which it appears to enter within the Disk of *Jupiter*; and its *Emerision* the Moment wherein it appears to come out. The *Immersion*s are observed from the Time of the Conjunction of *Jupiter* with the Sun, to the Time of his Opposition; and the *Emerisions* from the Time of his Opposition to his Conjunction. The peculiar Advantage of these Observations is, that during eleven Months of the Year they may be made at least every other Day. The Perfection of this Theory, and the Praxis thereon, we owe to Mr. *Cassini*.

IMMERSUS: see *Subscapularius*.

IMMUTATION: see *Hypallage*.

IMPALED, when the Coats of a Man and his Wife (who is not an Heiress) are born in the same

Escutcheon; they must be marshalled *in Pale*, the Husband's on the Right Side, and the Wife's on the Left; and this the Heralds call *Baron* and *Femme*, *two Coats Impaled*.

If a Man hath had two Wives, he may *Impale* his Coat in the middle between theirs; and if he hath had more than two, they are to be marshalled on each side of his, in their proper Order. See *Clifton's Coat* in *Guillim*, p. 399. who had seven Wives.

IMPARLANCE, or *Emparlance*, is a Motion made in Court upon the Account of the Demandant by the Tenant, or Declaration of the Plaintiff by the Defendant, whereby he craveth Respite, or any other Day to put in his Answer.

This *Imparlance* is either *General* or *Special*.

The *Special* is with this Clause, *Salvis omnibus advantagiis tam ad jurisdictionem curie quam breve & narrationem*.

The *General* is made at large, without inserting that or any other like Clause.

IMPASTATION, (in *Masonry*) a Work made of Stuc or Stone, beaten and wrought up in the manner of a Paste. Some Authors are of Opinion, that the Obelisks and the huge massy antique Columns, which are now remaining, were made some of them by *Impastation*, and others by *Fusion*.

IMPARSONEE, in the Law, or a Parson *Imparsonee*, is one that is inducted into the Possession of a Benefice. And *Dyer* saith, a Dean and Chapter are *Parsons Imparsonees* of a Benefice appropriate to them.

IMPEACHMENT of *Waste*, *Impetio vasti*, from the *French* *Empeschment*, *Impedimentum*, signifies in Law a Restraint from committing Waste on Lands and Tenements. And thus he that hath a Lease without *Impeachment of Waste*, hath by it a Property or Interest given him in the House and Trees, and may make *Waste* in them, without being *Impeached* for it; that is, without being question'd or demanded any Recompence for the Waste done.

IMPENETRABILITY, is the Distinction of one extended Substance from another, by which the Extension of one thing is different from that of another; so that two things extended cannot be in the same Place, but must of Necessity exclude each other.

IMPERATIVE-MOOD (in *Grammar*) implies a Command to such a one to do such a thing.

IMPERFECT CONCORDS: see *Concords*.

IMPERFECT Flowers of Plants, are such as want the *Petala*, or those finely-colour'd little Leaves, which stand round and compose the Flower: And therefore they are sometimes call'd *Apetalous*, and sometimes *Stamineous*; because they have only the *Stamina* and *Style* of a Flower.

IMPERFECT NUMBERS, are such whose Aliquot Parts taken all together, do either exceed or fall short of that Whole Number, of which they are Parts: And these are of two sorts, either *Abundant* or *Deficient*; which see.

IMPERFECT PLANTS, are by the Botanists accounted such as either really want Flower and Seed, or rather seem to want them; since no Flower or Seed hath yet been discover'd to belong to much the greatest part of them.

These Mr. *Ray* distinguishes according to the Place of their Growth; into,

I. *Aquatics*, or such as grow in the Water; and that either in the Sea, and then they are called



*Marine Plants*; and those are either of an hard and stony Consistence, as the *Corals*, *Corallines*, *Porus*;  
Or of a more soft and herbaceous one.

Of these some are like Herbs, and are of two Kinds:

The Greater, which are *Cauliferous*, as the *Fucus*;  
The Lesser, as the *Alga*.

The others are more of the *Muscus* or *Fungus* Appearance, as the *Spongia*.

*Fresh-water Plants*; and those have either no Leaves, but are *Capillaceous*, as the *Conferve*;

Or their Leaves divided into three Parts; as the *Lens palustris*, *Lenticula*.

II. Such *Imperfect Plants*, as inhabit the dry Ground, he divides into,

First, Such as have a Substance, either Woody, or Flehy; and these have scarce any thing common to the Perfect Plants, neither the green herbaceous Colour, nor the Texture of Herbs, nor Flower, Seed, nor Leaf, properly speaking, as all the *Fungi*; which are,

1. Such as grow on Trees, and therefore called *Arboreous*; as the *Fungus Laricis*, called *Agarick*; and the *Fungus Sambuci*, which we call *Jews-Ear*, *Auricula Judæ*, in *Latin*.
2. *Terrestrial*; and these are either *Cauliferous*, with Heads either *Lamellated* or *Porous* underneath; or without Stalks, as the *Pezizæ* of *Pliny*, and *Fungus Pulverulentus*, *Crepitus Lupi*, or common *Puff-Balls*.
3. *Subterraneous*; as the *Tubera Terræ*, or *Truffles*.

Secondly, Such as have a more soft and dry Consistence, and more like that of Herbs: Of which some are both *Cauliferous* and Branched, as the *Musci* or *Mosses*.

Others are without Stalks, adhering like a Crust to the Surface of the Earth, Stones, Trees, or Wood; as the *Lichen Terrestris* and *Arbo-reus*.

**IMPERIAL-TABLE**, is an Instrument made of Brass, with Box and Needle, and Staff, used to measure Land.

**IMPERSONAL-VERB**, in *Grammar*, is such an one as is only used in the third Person Singular, as *Oportet*, *Licet*, &c.

**IMPERVIOUS**: Bodies are said to be *Impervious* to others, when they will neither admit the Rays of Light, &c. nor the Effluvia of other Bodies to pass thro' them.

**IMPETIGO CELSI**, the same with *Lepra Græcorum*. *Celsus* makes four sorts of it.

The most harmless, says he, is that which is like a Scab, for it is red and hard, exulcerated and gnawed: But it differs from it, in that it is more exulcerated, and is accompanied with speckled Pimples: And there seem to be in it certain Bubbles, from which after a certain time there fall as it were little Scales, and it returns more certainly.

Another sort is worse, almost like a sort of Measles, or hot Pimples in the Skin, but more rugged, and redder, and of different Figures: In this Distemper little Scales too fall from the Surface of the Skin, and it is called *Rubrica*.

The third sort is yet worse; for it is thicker and harder, and swells more, and is cleft on the top of the Skin, and gnaws more violently: It is scaly too, but black, and spreads small and slow. It is called *Nigra*.

The fourth sort is altogether incurable, of a different Colour from the Red; for it is something white, and like a fresh Scar, and has pale Scales; some whitish, some like the little Pulse called *Lintel*, which being taken away, sometimes the Blood follows: Otherwise the Humour that flows from it is white, the Skin hard and cleft, and spreads farther.

All these sorts arise especially in the Feet and Hands, and infest the Nails likewise.

*Impetigo* some reckon the same with *Lichen Blanchard*.

**IMPETIGO PLINII**, *Pliny's Impetigo*, is the same with *Lichen Græcorum*. *Blanchard*.

**IMPLEAD**, in our Law, signifies to Sue, Arrest or Prosecute by Course of Law.

**IMPOST**, is the Tax which the Crown receives for Merchandize brought into any Haven within its Dominions, or from Foreign Parts; 31 *Eliz.* 5. and thus it may be distinguished from *Custom*; which is rather the Profit which the Queen makes of Wares exported: But they are frequently used promiscuously.

**IMPOSTS** in Architecture, are what are sometimes called *Chaptrrels*, being the Parts on which the Feet of Arches stand: Or the Capitals of Pilasters that support Arches. These *Imposts* conform to their proper Orders: The *Tuscan* hath a *Plinth* only: The *Dorick* two *Faces* and a *Round*: The *Ionick* a *Plancere* or Cavity between the two *Faces*; with sometimes carved Mouldings; as the *Corinthian* and *Composite* have their *Frieses*. But the *Sal-lies* of the *Imposts* must not exceed the Body of the Pilaster. Sometimes the Entablature of the Order serves for the *Impost* of the Arch; and this looks very great and stately.

**IMPOSTHUME** [*Aposthume*, F.] a Collection of Matter or Pus in any part of the Body, proceeding either from an Obstruction of Fluids in that part, which makes them change into such Matter; or from a Translocation of it from some other Part, where it is generated.

**IMPROPER FRACTIONS**, are such as have their Numerators equal to, or greater than their Denominators, as  $\frac{6}{6}$ ,  $\frac{12}{12}$ , &c. which are not Fractions properly speaking, but either Whole or Mixt Numbers; and are only put into the Form of Fractions, in order to be added, subtracted, multiplied, or divided, &c.

**IMPROPRIATION**, is the Word for the Profits of an Ecclesiastical Benefice, being in the Hands of a Layman: As *Appropriation* is the Term, when 'tis in the Hands of a Bishop, College, or Religious House. Tho' these two Words are now often used promiscuously. It is said there are 3845 Improprations in *England*. *Cowel's Interpreter*.

**IMPULSIVE** [*Impulsivus*, L.] a Term applied by Philosophers to the Action of a Body that impels or pushes another; as the Arm is said to give an *impulsive* Motion to the Stone that is thrown by it.

**IN Alto & Imo**; the same with *Alto & Basso*; which see.

**INAC-**



INACCESSIBLE HEIGHT or *Distance*, is that which cannot be Measured, by reason of some Impediment in the Way; as Water, &c.

INADEQUATE IDEA'S, are such, which are but a partial, or incomplete Representation of those Archetypes or Images to which the Mind refers them.

INANITY, is the School-Term for Emptiness, or absolute Vacuity, and implies the Absence of all Body and Matter whatsoever; so that nothing remains but bare Space.

INCALESCENCE, is a Thing growing hot by some Internal Motion, or Fermentation; as when Quick-lime grows hot by pouring Water upon it.

INCALESCENT MERCURY, so Mr. Boyle calls some Mercuries of an uncommon Preparation, which by being mingled with a due Proportion of Gold Leaves, or small Filings, would Amalgamate and grow hot with the Gold, even in the Palm of our Hand.

INCARNATION [in *Surgery*] the healing and filling up Wounds and Ulcers with new Flesh.

INCARNATIVES [in *Surgery*] Medicines that are proper to make Flesh grow, to rejoin or unite; also Bandages or Fillets, with an Eye or Noose at one End of them, to put the other End through.

INCARTATION [in *Chymistry*] a Method of purifying Gold by means of Silver and *Aqua Fortis*.

IN CASU CONSIMILI, is a Writ: see *Casu Provifo*.

IN CASU PROVISO, is a Writ: see *Casu Provifo*.

INCEPTIVE of *Magnitude*, is a Word used by Dr. Wallis, expressing such Moments or first Principles, as tho' of no Magnitude themselves, are yet capable of producing such. Thus a Point hath no Magnitude itself, but is *Inceptive* of a Line, which it produces by its Motion: A Line considered one way, hath no Magnitude as to Breadth, but is capable by its Motion of producing a Surface which hath Breadth, &c.

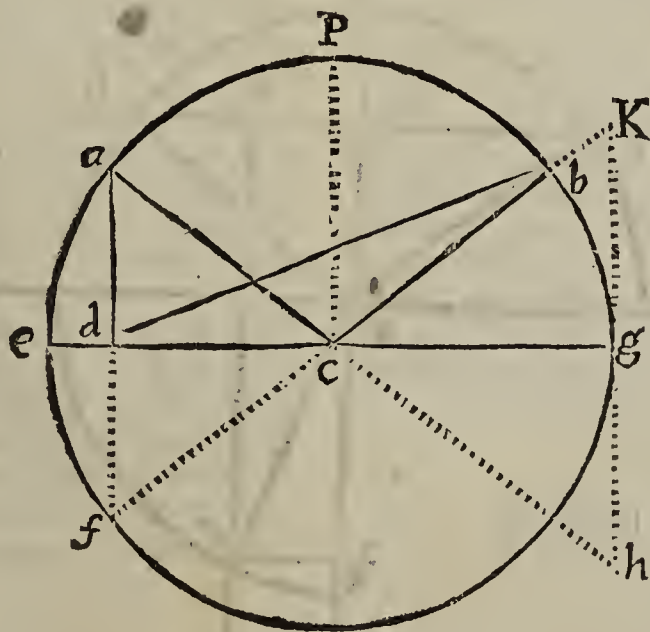
INCH, a known Measure, containing the Space of three Barley Corns in Length, and is the 12th part of a Foot.

INCERATION, is a mixture of Moisture with something that is dry, by a gentle Soaking, till the Substance be brought to the Consistence of Soft Wax. *Blanchard*.

INCIDENCE: In Opticks, the Angle  $a c P$ , made by the Ray  $a c$ , and the Perpendicular  $P c$ , is called the *Angle of Incidence*; but Dr. Barrow, and some others, call it the *Angle of Inclination*; and by the *Angle of Incidence*, they understand its Complement  $e c a$ .

Mr. Molyneux, in his *Dioptricks*, uses the Words *Inclination* and *Incidence* promiscuously, and by the *Angle of Incidence* or *Inclination*, always intends the first named Angle  $a c P$ .

The Angle  $P c b$ , is called *The Angle of Reflexion*, and is always  $=$  to the Angle of *Incidence*  $a c P$ : Which is thus proved by *Leibnitzius*.



Every Ray of Light goes the *shortest Way* that possibly it can: But if you suppose the Ray  $a c$  to fall on the Plane-Glass, or Surface  $eg$ , and thence to be reflected to  $b$ , so that the Angle  $a c e$  be  $= b e g$ , then will the two Lines  $a c$  and  $c b$  be the two shortest Lines that can possibly be drawn from the Points  $a$  and  $b$ , to the Plane  $eg$ : For Instance, they will be shorter than  $a d + d b$ , or any others.

Produce  $c b$  to  $f$ , and draw  $d f$ , because the opposite Angles at  $c$  are  $=$ ; the Arch  $e f$  ( $= b g$ )  $= a e$  by the Supposition; but 'tis plain that  $f c = a c$ , and  $c f = c b$ . Wherefore  $f b$  ( $= a c + c b$ ) will be less than  $d f$  (i. e.  $a d$ )  $+ d b$ : and so it will be every where else. Wherefore since the Ray must go the nearest way, the Angle of *Incidence* will always be  $=$  to that of *Reflexion*: For the two Angles  $e c a$  and  $b c g$ , being thus equal, their Complements  $a c P$  and  $P c b$  must be so too.

That the *Angle of Incidence*  $a c P$ , is  $=$  to that of *Reflexion*  $P c b$ , may very briefly be thus proved.

Produce the Ray  $a c$  directly till it meet with the Perpendicular  $g h$  in the Point  $b$ : Then make  $g R$

$= g b$ , and draw  $c K$ : I say  $c K$  is the Reflected Ray, and that the Angle  $P c k = r c P$ : For  $P$  being drawn perpendicular to the Plane  $eg$ , the Angle  $e c a + a c P = K c g + P c K$ ; because both are  $= L$ : But  $e c a = g c h$ , because Vertical, and  $c g h = g c K$  by Construction. Wherefore  $e c a = b e g$ : And consequently their Complements  $a c P$  and  $P c b$  are equal. Q. E. D.

In *Dioptricks*, the Sines of the *Angles of Incidence*, and *Refracted Angles*, are to each other reciprocally, as the Resistances of the Mediums, as is demonstrated by *Leibnitz* in *Acta Erud. Lipsiæ, Anno 1682. p. 185*. And in Mr. Molineux's *Dioptrica Nova*, Part II. Chap. 1:

Sir Isaac Newton discover'd, That from Air to Glass, the Sine of the Angle of *Incidence*, is to the Sine of the Refracted Angle: : as 300 : to 193, or nearly, as 14 to 9.

And on the contrary, That from Glass to Air, the Sine of the *Incidence*: is to the Sine of the Refracted Angles: : as 193 : to 300, or as 9 to 14.

But

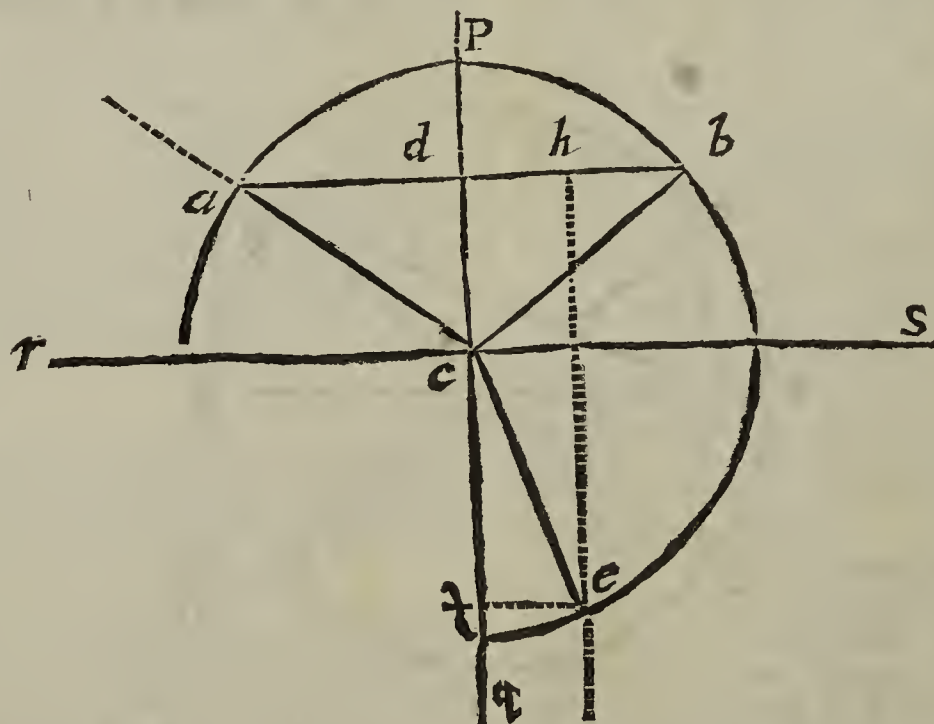


But in his Dissertations concerning *Light and Colours*, he has demonstrated, that the Rays of Light are not all *Homogeneous*, or of the same sort, but of different Forms and Figures; so that some are more Refracted than others, tho' they have the same or equal Inclinations on the Glass: And therefore there can be no constant Proportion set between the Sines of the *Incident*, and *Refracted Angles*.

But the Proportion that comes nearest the Truth, for the middle and strong Rays of Light, is nearly as 300 to 193, 14 to 9.

**INCIDENCE.** Sir *Isaac Newton*, in his *Opticks*, Printed since the first Edition of this Book, saith, That the *Sine of Incidence is either accurately, or very nearly, in a given Ratio to the Sine of Refraction*: (And the Angles of *Incidence*, *Reflexion*, and *Refraction*, are all in one and the same Plane.) Wherefore if that Proportion be known in any one Inclination of the Incident Ray, 'tis known in *all*; and thereby the Refraction in all Cases of *Incidence* on the same Refracting Body may be determined. Thus, if the Refraction be made out of Air into Water, the Sine of *Incidence* of the Red Light is to the Sine of the Refraction, as 4 to 3. If out of Air into Glass, the Sines are as 17 to 11. In Light of other Colours the Sines have indeed other Proportions; but the Difference is so little, that it need seldom be consider'd.

To illustrate all this, Sir *Isaac Newton*, *Opt.* p. 5. gives this Example:



Let *r s* be the Surface of the Still Water, *c* the Point of *Incidence*, in which any Ray coming in the Air from *a* in the Line *a c*, is reflected or refracted. I would know whither this Ray shall go after such Reflection or Refraction.

On the Surface of the Water *r s*, and in the Point *c*, I erect the Perpendicular *c p*, and produce it downwards to *q*. Knowing therefore that the Ray after Reflexion or Refraction will be found somewhere in the Plane of the Angle of *Incidence a c p* produced: I let fall the Sine of that Angle (*viz. a d*) on the Perpendicular *p c*; and then if the Reflected Ray be sought, I produce *a d* to *b*, so that *db = ad*, and draw *c b*, which shall be the Reflected Ray, because the Angle of Reflexion and its Sine, are equal to the Angle and Sine of *Incidence*, as they ought to be. But if the Refracted Ray had been sought, I produce *a d* to *h*; so that *dh* may be to *ad*, as the Sine of Refraction to that of *Incidence*; *i. e.* as 3 to 4. Then with the Radius *a c*, describing the Circle *a b e*, and in the Plane *a c p*, I draw the Line *b e* parallel to *p q*, and cutting the Circumference in *e*: Then drawing *c e*, that shall be the Refracted Ray. For if *e f* be let fall perpendicularly on the Line *p q*, it shall be the Sine of the Angle of Refraction of the Ray *c e*; and this Sine is equal *dh*, and consequently in proportion to the Sine of the Angle of *Incidence a d*, as 3 to 4.

**INCIDENCE-POINT**, (in Opticks) is that Point in which a Ray of Light is supposed to fall on a Piece of Glass.

**INCIDENT**, in the Law, signifies a thing necessarily depending upon another, as more principal. Thus a *Court Baron* is so *Incident* to a Manor, and a Court of *Pie-Powdre*, that they cannot be severed in a Grant of a Manor or *Fair*, but must go along with it.

**INCIDENT-RAY**, in *Catoptricks* and *Dioptricks*: see *Ray of Incidence*.

**INCIDING Medicines**, are such as consist of pointed and sharp Particles, as Acids and most Salts; by the Force or Insinuation of which, the Particles of other Bodies which before cohered, are incided, cut into, or divided from one another: And thus expectorating Medicines, which cut the Phlegm, so as to occasion a Discharge, are said to *incide*, or be *inciding Medicines*.

**INCINERATION**, is the reducing the Bodies of Vegetables and Animals into Ashes by a violent Fire.

**INCISIVUS**, is a Muscle which pulleth the Upper Lip upwards.

**INCISORES DENTES**, the same with *Primores*.

**INCISIVI**, the same with *Primores*.

**INCLINATION**, is a Word frequently used by Mathematicians, and signifies the mutual Approach, Tendency or Leaning of two Lines or two Planes towards each other, so as to make an Angle.

What the *Angle of Inclination* signifies in Opticks, see in *Incidence*.

The *Inclination* of two Planes, is the acute Angle made by two Lines, drawn one in each Plane, and perpendicular to their *Common Section*.

**INCLINATION of the Axis of the Earth**, is the Angle which it makes with the Angle of the Ecliptick; or the Angle between the Planes of the Equator and Ecliptick.

**INCLINATION of a Planet**, is an Arch of the Circle of *Inclination*, comprehended between the Ecliptick,



### Ecliptick and the Plane of a Planet in his Orbit.

INCLINATION of a *Plane*, in Dialling, is the Arch of a Vertical Circle, perpendicular to both the *Plane* and the *Horizon*, and intercepted between them.

*To find the Inclination of a Plane.*

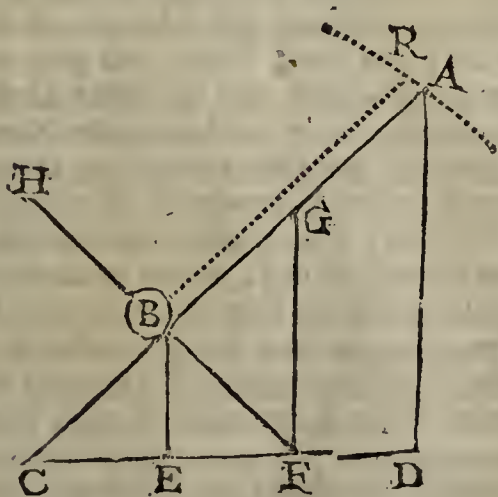
Take a Quadrant, and apply its Side to the Side of a Square, and apply the other Side of your Square to your *Plane*; if the Plummet fall parallel to the Side of the Square, then the lower Side of the Square stands level; by which draw an Horizontal Line, whereon erect a Perpendicular, and apply your Square to that Perpendicular, and if the Plummet falls parallel to the Side of the Square, then that is also a level Line, and your Plane stands horizontally: If the Plummet falls not parallel to the Side of the Square, then turn your Square until it does, and draw an Horizontal Line, on which erect a Perpendicular, to which apply your Square, and observe what Angle your Plummet makes on the Quadrant, with the Side of the Square; that is the Angle of the *Inclination of the Plane*.

**INCLINATION** of a Ray, in Dioptricks, is the Angle which this Ray makes with the *Axis of Incidence* in the first *Medium*, at the Point where it meets the second *Medium*.

INCLINATION of a Right Line to a Plane, is the acute Angle, which this Right Line makes with another Right Line drawn in the Plane, through the Point where the inclined Line intersects it, and thro' the Point where it is also cut by a Perpendicular drawn from any Point of the inclined Lines.

INCLINATIONS of the Planes of the Orbits of the Planets, to the Plane of the Ecliptick, are thus: *Saturn's* Orbit makes an Angle of 2 Degrees 30 Minutes; *Jupiter's* 1 Degree, and  $\frac{1}{3}$ ; *Mars's* little less than 2 Degrees; *Venus's* is 3 Degrees, and  $\frac{1}{3}$ ; *Mercury's* is almost 7 Degrees.

**INCLINED Plane.** If a Body, as *B*, be partly supported by the *Inclined* Plane *AC*, and partly by the Power *R* acting on a Direction parallel to the Plane *AC*. Then that Power *R*: is to the Body or Weight *B* :: as the Sine of the Angle of the Plane's Inclination *ACB*: is to the Radius *CA*. *CD*, *AD*, *GF*, *ED*, and *HF*, being drawn as in the Figure.



The Body  $B$  will be sustain'd as it were by three Forces or Powers, all acting according to different Directions, and in *Equilibrio* to one another. The First of which is the *Force of Gravity*, express'd by  $BE$  perpendicular to the Horizon  $CD$ . The Second the Power  $R$ , according to the Direction  $BR$  parallel to the Plane  $AC$ . And the Third is supply'd by the Resistance or Contranitence of the Plane  $AC$ ; and is express'd by  $BH$  perpendicular thereunto.

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For Action and Re-action being equal; and one acting directly contrary to the other; the Plane which is pressed by the Body or Weight  $B$ , according to the Direction of the Perpendicular  $HB$ , must act on that Body by a contrary Direction, *viz.* that of  $FB$  or  $BH$ . And since these three Powers are all mutually in *Æquilibrio*, (and that the Body  $B$  is sustained by them, 'tis plain (when  $GF$  is drawn perpendicular to  $CD$ , or parallel to  $BE$ ) that the Force of Gravity will be expressed by  $GF$ ; and that the Power  $R$ : to the Power of Gravity :: will be as  $GB$ : to  $GF$ : But in the Right-angled Triangle  $CFG$  ( $FB$  being a Perpendicular to the Base  $CG$ )  $BG:GF::GF:GC$ ; and as  $FG:GC::AD:AC$ : (by Similar Triangles;) wherefore the Power  $R$ : is to the Force of Gravity :: As  $AD$ : to  $AC$ ; or as the Sine of the Angle of Inclination to the Radius. *Q. E. D.*

C O R O L L A R Y I.

Wherefore the Force by which any heavy Body wou'd descend on any *inclined* Plane to the Force of the Descent in the Perpendicular, is as the Sine of the Angle of the Plane's Inclination to the Radius.

C O R O L L A R Y II.

From hence also it follows, that the Inclination of the Plane may be so little, that the greatest Weight may be sustain'd on it by the least Power.

For Practice therefore, Let the Weight of any Body be  $W$ , and  $P$  the Power wanted to sustain it on an *Inclined Plane*.

I say, by this Theorem,  $R : W :: S \text{ Incl.} : P$ . That is, as Radius is to the Weight :: so is the Sine of the Angle of the Plane's Inclination to the Horizon: to the Power sought. The three first of which are given: Wherefore the Fourth is known. *Trigon. Calculation, E G.* Let a Body weigh 9999 Pound; What Power will sustain it from descending on a Plane inclined to the Horizon with an Angle of 34 Degrees? Answer, 5590 Pound weight.

See the Work.

$R = 10.$

Weight 9999. 3.999957  
S,  $\angle$  Incl. =  $34^\circ$ . 9.747562

$$Z - R = 3.747419 = 5590 \text{ Ferè.}$$

INCLINING *Direct South or North Dials*: see *Direct South or North Inclining Dials*.

**INCLINING** *Declining Dials*: see *Declining Inclining Dials*.

INCLINING *Planes*, are those which lean or incline to the Horizon.

INCOMBUSTIBLE Cloth, is a sort of very odd Linen, made from a Stone in the Form of a Talk; and call'd *Lapis Amianthus* and *Asbestos*, *Alumen Plumosum*, *Polia*, *Corssbides*, *Sparta Polia*, &c. 'Tis found in many Places in *China*, *Italy*, and *Wales*; and I have had a very clean sort, which would part into pretty long Threads, which was found in *Scotland*. The *Incombustible Cloth* made from this Mineral, is called *Linum Vivum*, *Linum Fossile*, *Linum Indicum*, *Creticum*, *Cyprium*, &c. from the Places where 'tis found. This was of such Esteem among the Ancients, as to be rank'd (as Dr. Plot tells us) with the most precious Pearls. And in *China* a Piece of it, but  $23\frac{3}{4}$  Inches long, was valued at 80 *Tale*, i. e. 36 *l.* 13 *s.* 4 *d.* Pliny tells us expressly, and of his own Knowledge, That Napkins of this Cloth being taken foul from the Table at a great Feast, where he was a Guest, were



cast into the Fire, and by that means came out fairer and cleaner than if they had been wash'd in Water. *Marco Antonio Castagna*, Superintendant of some Mines in *Italy*, saith (in *Phil. Transf.* N. 72.) that causing a kind of Paper to be made of some of the *Amiantus* which he found there, it would abide longer in the Fire without being consumed, than Plates of the hardest and most solid Metal; which would have scaled off in Flakes with a much less Heat. Mr. *Edward Lloyd* also, in *Numb.* 166. gives an Account of some that he found in *Wales*, which remained in the Fire above a Quarter of an Hour without any Signs of being consumed.

But in two Trials which were made before the Royal Society of a Piece of this Cloth of a Foot long, and half a Foot broad, and weighing about an Ounce and half, it was found to lose in a strong Fire, where it continued for several Minutes, above a Dram of its Weight at a time.

Of this Cloth, as *Pliny* informs us, Shrouds were anciently made, and used at *Royal Obsequies*, to wrap up the Corps in, that the Ashes of their Bodies might be preserved distinct from those of the Wood, which constituted the Funeral Pile. And we are assured, that the Princes of *Tartary* use it for the same purpose to this Day. And some of the ancient *Indian Brachmans* are said to have made themselves Cloaths of it. They tell us also, that the *Wicks* for the Ancients perpetual Lamps (if there were any such thing) were made of the Threads of this *Alumen Plumosum*, or *Asbeston*.

*Marcus Paulus Venetus* acquaints us, That one *Curficar* a *Turk*, a Superintendant of the Mines in the *Tartarian* Province of *Chinchinthalas*, assured him that they first dried this Mineral (found there in a certain Mountain) in the Sun; then pounded it in a Brass Mortar, to separate the earthy Part from it; and that afterwards it was also washed from all remaining Filth; and then was spun into Threads like Wool, and afterwards woven into Cloth; which, said he, when spotted or foul, they cleanse by throwing it into the Fire for an Hour's time, whence it comes out unhurt, and as white as Snow.

**INCOMMENSURABLE**, a Term in Geometry, used where two Lines, when compared to each other, have no common Measure, how small soever, that will exactly measure them both; so that after ever so many Repetitions and Subtractions of equal Parts, there will always remain some Part, by which the one is greater than the other. And in general, two Quantities are said to be *Incommensurable*, when no third Quantity can be found that will exactly measure them both; or when those Quantities are to one another as Number to Number, or cannot be express'd by Numbers: For every thing that may be express'd by Number is commensurable. The Side of a Square is *incommensurable* to the Diagonal, as is demonstrated by *Euclid*; but it is commensurable in Power; the Square of the Diagonal being equal to twice the Square of the Side. *Pappus*, Lib. 4. Prob. 17. speaks also of *incommensurable* Angles. As to Surfaces which cannot be measured by a common Surface, they are said to be *incommensurable* in Power.

**INCOMMENSURABLE Numbers**, are such as have no common Divisor that will divide them both equally.

**INCOMMENSURABLE Quantities**, are those which have no Aliquot Parts, or any common Measure that may measure them; as the *Diagonal* and Side of a Square: For altho' that each of those Lines have infinite Aliquot Parts, as the Half, the

Third, &c. yet not any Part of the one, be it never so little, can possibly measure the other, as is demonstrated in 117. *El.* 10. *Eucl.*

**INCOMPLEX Terms**, in Logick: see *Complex*.

**INCOMPOSITE Numbers**, are the same with those *Euclid* calls *Prime Numbers*. In Dr. *Pell's* Edition of *Brancker's Algebra*, there is a Table, as it is there called, of *Incomposite Numbers*, less than 100000; tho' it contains far more *Composite* than *Incomposite Numbers*: For it doth not only give an orderly Enumeration of all odd Numbers which are not *Composite*, but it shews also that none of the rest are so. This Table being of very great Use, I have here placed. It hath 21 Columns throughout; whereof the first contains 40 *Odd Numbers* in their natural Order. The following Columns are distinguished on their Tops, by their Numbers, in their natural Order; as 0, 1, 2, 3, &c. and so on to 99999. These *Top Numbers* are *Hundreds*; and the 40 marginal Numbers are Units adhering to those *Hundreds*. A Line running from any of the *Marginal*, as he calls them, (or Numbers in the first Column) across the Page, shews in any intermediate Column the Place of the Number made up of the *Top* Number and that *Marginal*. In every such Place of Concourse, you shall either find the Letter p, or some Prime Number less than 317. If p be there, it shews the Number to be a *Prime* or *Incomposite*. The whole Table consists of 50 Pages, or so many several Tables, number'd: In some one of which, if any Number be less than 100000, and do end either in 1, 3, 7, or 9, you may find its Place; and then see whether it be a Prime or not. If it be not a *Prime*, but *Composite*, you will there find its *least Divisor*. Thus for instance, in Table I. where the Line mark'd with the Marginal 67, crosses the Column which hath 16 at the Top, there you find the Letter p, which shews you that 1667 is a Prime or *Incomposite Number*. But where that Line crosses the next Column, you find 3, which shews you that 1767 is not a Prime but *Composite* Number; and that 3 is its least Divisor. So also in Table XXV. you see that 49031, 49033, and 49037, are all Prime or *Incomposite Numbers*: But 49039 is a *Composite*, and 19 is its *least Divisor*.

It will oftentimes be of very great use to have, as you may have here, a compleat orderly Enumeration of all Prime or *Incomposite Numbers* between 0 and 100000, without any Mixture of *Composites*; as the p's in these Tables will give you, leaving out 9, 21, &c. and all other *Composites*. 'Tis true that 2 and 5 are *Incomposite Numbers*, as well as 1 and 3; but they are not put into the Tables, because no other *Incomposite Numbers* can terminate in them: For if any Number end in 12, it may be halved; if in 5, it may be divided by 5.

If to each of these Primes you set the *Briggian Logarithm*, you may find the Logarithm for all the rest of the Numbers in the first Hundred Chiliads, by Addition of the Logarithms of their *Incomposite* Factors.

In perplex'd Questions in Algebra it is oftentimes necessary to be able to determine how many *aliquot Parts* and *Divisors* any proposed Quantity or Number may have; for which Purpose these Tables are of excellent Use.

Every Aliquot Part of a Number is one of its just Divisors; but the *greatest Divisor* being equal to the *whole Dividend*, cannot be call'd a Part.

If you have the least Divisor of any Number in these Tables of *Incomposites*, you may find all its other *Incomposites* Co-efficients.

For



For if the Divisor end in 1 or 9, and have a black Stroke *under* it, in the Dividend's Place in the Tables; or if the Divisor end in 3 or 7, and have such a Stroke *over* it in the Dividend's Place; then the Dividend is the *Square* of an *Incomposite*, and consequently the *Quotient* is given, being *equal* to the Divisor.

If the *least Divisor* hath no such Stroke by it, let it divide the Number proposed; so shall the Quotient be the greatest *Aliquot Part* of that *Dividend*. Then seek that Quotient itself also in the Tables; if you find it there mark'd with p, it is a *Prime* or *Incomposite*, and you can proceed no further; your Enquiry is at an end.

Thus the Number 53191 is found in Table XXVII. with its *smallest Divisor* 43; and being divided by that 43, the Quotient is 1237. And in Table I. finding 1237 to be a *Prime Number*, I proceed no further.

But had the Number been 93611, you will find in Table XLVII. that 7 is its *least Divisor*; and that the Quotient will be 13373. This stands in Table VII. with 43 for its *least Divisor*, and the Quotient will be 311; which in Table I. I find to be an *Incomposite*: I conclude therefore, that the Prime Co-efficients of 93611 are 7, 43, and 311.

If you divide any Odd Number by all the Primes in Order, beginning with 3; then the first Divisor that finds a Quotient without Fraction, is the least Divisor that Dividend can have. If no such Divisor find an Integer Quotient, before the Quotient becomes less than the Divisor, you may pronounce your Dividend to be *Incomposite*; and that that last Divisor is greater than the Square Root also of the Dividend.

Frequent Occasion of dividing by *Incomposites* requires a *Tariffa* of as many *Primes* as shall be needful; but for resolving of Numbers less than 100000, it sufficeth if it be extended to 313. And such an one you have at the Beginning of these Tables of *Incomposite Numbers*.

INCONGRUITY: see *Congruity*.

INCORPORATE: To *Incorporate*, in Chymistry or Natural Philosophy, signifies accurately to mix the Particles of one Body with another.

INCORPORATION, [in *Pharmacy*] is the mixing the Particles of different Bodies so together, as to make an uniform Substance or Composition of the whole, so that the Ingredients or Bodies mix'd cannot be discerned in any of their particular Qualities.

INCRASSATING, or thickening things, are those which being endued with thick ropy Parts, and mix'd with thin liquid Juices, bring them to a thicker Consistence, by joining and knitting their Parts together. *Blanchard*.

INCRUSTATION, [in *Architecture*] an Ornament that consists of hard polish'd Stones or other brilliant Matter, disposed in Compartments in the Body of a Building. Also Walls lined with Stone or Marble are said to be *Incrustated*.

INCRUSTED Column [in *Architecture*] is one which consists of several Pieces of slender Branches of some precious Marble, masticated or cemented round a Mould of Brick, or other Matter. This is done not only to save the precious Stone, whether it be Agate, Jasper, or the like, but that the Pieces may appear of an extraordinary Largeness, by reason of the Closeness and Neatness of the Incrustation; so that the Mastic being of the same Colour, the Joints are imperceptible.

INCUBUS: see *Ephialtes*.

INCUMBENT, in Common Law; is a Clerk

resident on his Benefice with Cure; and called *Incumbent* of that Church, because he doth or ought to bend his whole Study to discharge his Cure.

INCURVATION of the Rays of Light: see *Light* and *Refraction*.

INCUS, the Anvil, is a Bone of the inner Part of the Ear: It is like a Grinder-tooth, and lies under the Bone call'd *Malleus*. It has two Legs, the shorter of which is tied to the Side of that Conduit or Passage which goes to the *Processus Mammillaris*; and the longer Leg to the Head of the third Bone, called the *Stapes*.

INDAGATOR, a Searcher or Enquirer into Nature.

INDEFEISIBLE, in our Law, signifies what cannot be defeated or made void: As a good and *indefeisible* Estate.

INDEFINITE, is what hath no Bounds or Limits determined; or what is consider'd as not having any.

INDEMNITIES. When a Church is Appropriate to an Abbey or College, then the Archdeacon loseth his Induction-Money for ever: In Recompence whereof he shall have yearly out of the Church so Appropriate *One* or *Two* Shillings, more or less, for a Pension, as was agreed at the Time of the *Appropriating*. And this Pension is call'd an *Indemnity*.

INDENTED, a Term in Heraldry, when the Out-line of a Bordure, Ordinary, &c. is in the Form of the Teeth of a Saw; thus,



INDENTURE, is a Writing comprising some Contract between two, and being *indented* in the Top answerable to another, that likewise containeth the same Contract.

INDETERMINED Problem, in Geometry: see *Local*.

INDEX, is the same with what is sometimes called the *Characteristick* or Exponent of a Logarithm; and sheweth always of how many Places the Absolute Number belonging to the Logarithm doth consist, and of what Nature it is; *i. e.* whether an Integer or a Fraction: Thus, in this Logarithm 2.562293, the Number standing on the Left-hand of the Point is call'd the *Index*; and because it is 2, shews you that the absolute Number answering to it consists of 3 Places; for 'tis always one more than the *Index*, because the *Index* of 1 is 0; of 10 is 1; of 100 is 2, &c.

As in this Example;

0	1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9	

Where the upper Numbers are *Indices* to the lower. And therefore in those small Tables of *Briggs's* Logarithms, where the *Index* is omitted, it must always be supplied before you can work by them. If the absolute Number be a Fraction, then the *Index* of the Logarithm hath a negative Sign, and is marked thus, 2.562293; which shews the corresponding Number to be a Decimal Fraction of 3 Places, *viz.* 1.365. See *Logarithms*.

Mr. *Townly* hath a peculiar way of noting these *Indices*, when they express Fractions, and 'tis now much in Use, *viz.* by taking instead of the true *Index*, its Arithmetical Complement to 10; and there.



therefore he would write the Logarithm now mention'd thus, 8.562293. How they are added and subtracted, see in *Addition* and *Subtraction*.

**INDICATION**, a Word used by Physicians and Surgeons, and signifies a Discovery of what is to be done, and what Course to be taken for the Recovery of the Patient's Health; as if on Examination Bleeding be found necessary, they say, Bleeding is *indicated*.

**INDICATIONS** are usually accounted threefold:

1. *Preservatory*, which shew what is to be done for the Continuation and Preservation of Health.

2. *Curative*, which shew how the Disease is to be removed, that the Patient at present labours under. And,

3. *Vital*, which respect the Patient's Life, Strength and way of living.

**INDICATIVE-MOOD**, in Grammar, demonstrates simply what we affirm.

**INDICATOR**: see *Extensor Indicis*.

**INDICAVIT**, is a Writ or Prohibition, that lieth for a Patron of a Church, whose Clerk is Defendant in Court-Christian, in an Action of Tythes commenced by another Clerk, and extending to the fourth part of the Church, or of the Tythes belonging to it; for in this Case the Suit belongeth to the King's Court; wherefore the Patron of the Defendant being like to be prejudiced in his Church and Advowson, if the Plaintiff obtain in the Court-Christian, hath this Means to remove it to the King's Court.

**INDICTION**: see *Cycle of Indiction*.

**INDICTMENT**: see *Enditement*.

**INDIGESTION** [in *Physick*] a Want of Digestion. It is a Crudity that may be very naturally accounted for, from the Relaxation of the Fibres of the Stomach.

**INDIGNATORIUS**, an Epithet attributed to the fourth straight Muscle of the Eye, because that Motion or Cast of the Eye is peculiar to Men in the Passion of Anger. For this Muscle being one of the *Abducent*, serves to draw the Eye outward from the inner Corner to the outer.

**INDIRECT Modes of the Syllogisms** [in *Logick*] are the five last Modes of the first Figure, express'd by these barbarous Words, *Baralipton*, *celantis*, *dabitis*, *Frisemorum*.

**INDIVIDUUM**, in *Logick*, is that which signifies but one only thing: Of which they make a fourfold Division.

1. *Individuum Vagum*, is that which tho' it signifies but one thing, yet may be any of that kind; as when we say, *A Man*, *A certain Person*, or *One* said so or so; tho' but one Person is meant, yet that one Person, for ought appears to the contrary, may be any Body.

2. *Individuum Determinatum*, is when the Thing is nam'd or determin'd; as *Alexander*, the River Nile, or Mount *Athos*: This also is called *Signatum*.

3. *Individuum Demonstrativum*, is when some demonstrative Pronoun is used in the Expression; as *This Man*, *That Woman*.

4. *Individuum ex Hypothesi*, or by Supposition; when an universal Name or Term is restrained by the Supposition to a particular Thing; as when we say, the *Son* of such an one, and it be known that he had but one Son.

**INDIVISIBLES**, in Geometry, are such Elements or Principles as any Body or Figure may ultimately be resolved into. And these *Elements* or *Indivisibles*, are in each particular Figure supposed to be infinitely small.

With regard to which Notion, a Line may be said to consist of Points, a Surface of Parallel-Lines, and a Solid of Parallel and Similar Surfaces: And then, because each of these Elements is supposed *Indivisible*, if in any Figure a Line be drawn thro' the Elements perpendicularly, the Number of Points in that Line, will be the same as the Number of the Elements.

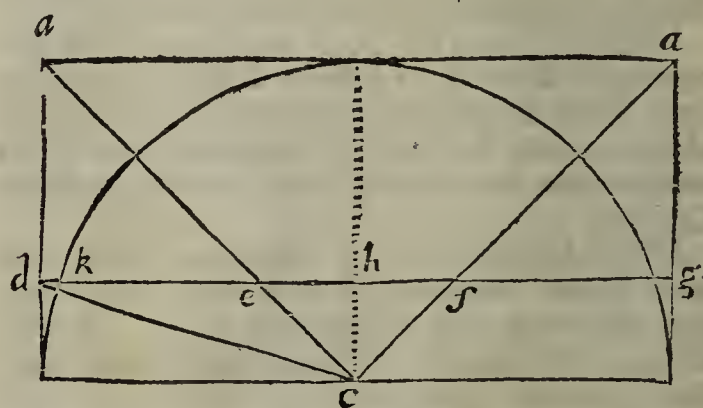
Whence we may see, that a Parallelogram, Prism or Cylinder, is resolvable into Elements, or *Indivisibles*, all equal to each other, parallel, and like to the Base. A Triangle into Lines parallel to the Base, but decreasing in Arithmetical Proportion, and so are the Circles which constitute the *Parabolick Conoid*, and those which constitute the Plane of a Circle, or the Surface of an Isosceles Cone.

A Cylinder may be resolved into Cylindrical Curve Surfaces, having all the same Height, and continually decreasing inwards, as the Circles of the Base do, on which they insist.

This *Method of Indivisibles*, is only the ancient *Method of Exhaustions* a little disguised and contracted: It was first introduced by *Cavallerius* in his *Geometria Indivisibilium*, Anno Dom. 1635, pursued after by *Torricellius* in his Works, printed 1644, and again by *Cavallerius* himself in another Treatise, published 1647: And is now allowed to be of excellent Use in the shortening of mathematical Demonstrations: Of which take the following Instance in that famous Proposition of *Archimedes*;

That *A Sphere is two Thirds of a Cylinder*  
circumscribing it.

For suppose (as in the Figure) a Cylinder, Hemisphere, and an Inverted Cone, to have the same Base and Altitude, and to be cut by Infinite Planes all parallel to the Base, of which *dg* is one: 'Tis plain, the Square of *dh* will every where be equal to the Square of *KC* (the Radius of the Sphere) the Square *bc* = *eb* Square; and consequently, since Circles are to one another, as the Squares of the Radii, all the Circles of the Hemisphere will be equal to all those of the Cylinder, deducting thence



all those of the Cone: Wherefore the Cylinder, deducting the Cone, is equal to the Hemisphere; but 'tis known, the Cone is one third of the Cylinder, and consequently the Sphere must be two thirds of it. Q. E. D.

**INDIVISUM**, in our Law, is used for that which two Persons hold in common, without Partition. *Kitchin*, fol. 241. in these Words; He holds *pro Indiviso*, &c.

**INDORSEMENT**, is any thing written on the Back of a Deed or Instrument; as a Condition, written on the Back of an Obligation, is commonly call'd an *Indorsement*.

**INDUCTION**, is commonly taken for the giving Possession to an Incumbent of his Church, by leading him into it, and delivering him the Keys, by the



the Commissary or Bishop's Deputy, and by his ringing one of the Bells.

When a Clerk is instituted into a Benefice, he is to exhibit his Mandate from the Bishop to the Archdeacon, or other Person to whom it is directed; and hath a Right thereby to be *Inducted* into his Living: And if he be refused *Induction*, he hath a Remedy both in the Ecclesiastical Court, and also an Action of the Case in the Common Law, against the Archdeacon. If the *Inductor*, or Person to be inducted, be kept out of the Church or House by Laymen, the Writ de *Vi Laicâ* lies for the Clerk; which is directed out of the *Chancery* to the Sheriff of the County, to remove the Force, &c. If another Clergyman, presented by the same Patron, keep Possession, a *Spoliation* is grantable out of the Spiritual Court; whereby the Tithes, &c. shall be sequestred till the Right be determined.

The Archdeacon rarely inducts a Clerk by himself in Person, but issues out a Warrant to all Clerks and Letter'd Persons within the Archdeaconry, empowering any of them to do it in his stead. The usual Form and Manner of *Induction* is, for the *Inductor* to take the Clerk by the Hand, and then to lay it on the Key of the Church, which must be then in the Door, and to say, *By Virtue of this Instrument, which is the Archdeacon's Warrant, I induct you into the Real, Actual, and Corporal Possession of the Rectory or Vicarage of A. with all its Fruits, Profits, Members, and Appurtenances.* This done, he opens the Door, and puts the Clerk in Possession of the Church, and shuts the Door upon him; who, after he hath tolled a Bell (if there be any) comes out, and desires the *Inductor* to indorse a Certificate of his *Induction* on the Archdeacon's Warrant, and that all present will signify it under their Hands.

If the Church Key cannot be had, 'tis sufficient that the Clerk lay hold of the Ring of the Door, and within the time limited read the Common-Prayer and Thirty-nine Articles in the Church Porch. If there be no Church, he may lay his Hand on the Wall or Fence of the Church-yard, &c. there being no Necessity of Niceness as to the Form of *Induction*; only that he must have Witness that he was truly possess'd of it. Within two Months after this, the Clerk must read the Thirty-nine Articles, and all the Service of the Day both at Morning and Evening Prayers; and declare his Assent and Consent; and he must then also read the Bishop's *English Certificate*, in which is the Declaration of his Conformity; and of all this he must have two or three good Witnesses, who must sign that they heard him do it, and be ready to attest it *vivâ voce*, if required: And within three Months after *Induction*, he must take also the Abjuration Oath at the Quarter-Sessions, or in some one of the Courts in *Westminster*.

INDURANTIA: see *Sclerotica*.

INDUSIUM: see *Amnios*.

INEDIA, is abstaining from Meat, when one eats less than formerly.

INEFFABLE-NUMBERS, the same with *Surd-Numbers*.

INEQUALITY of Natural Days. Tho' the Sun is supposed vulgarly to measure our Time equally, yet he is very far from doing so: And as 'tis impossible for a good Clock, or Movement, to keep time with the Sun; so one that is truly such, will measure Time much more truly, and go exacter than any Sun-Dial.

The usual Reason, and one good one it is, of the *Inequality* of Natural Days, you have under the

Word *Equation of Time*: But the truth is, there is also another; and that is, That the Motion of the Earth itself round its Axis, is not exactly equable or regular, but is sometimes swifter, and sometimes slower.

INERGETICAL Bodies or Particles, are such as are sluggish and unactive.

INESCUTCHEON in Heraldry, signifies all the Escutcheons, containing  $\frac{1}{4}$  of the Field, and is born within it as an Ordinary, thus:

He beareth *Ermin*, an *Inescutcheon Gules*.

This is also sometimes called, An *Escutcheon of Pretence*; which is born when a Man marries an Heiress: For then he bears her Coat of Arms on an *Inescutcheon*, or *Escutcheon of Pretence*, in the Middle of his own Coat.



INFANGETHEF, is a Liberty granted from the King to some Lords of Manors, to try all Thieves, which are their Tenants, within their own Courts.

INFERIOR Planets, are *Mercury* and *Venus*, so called, because they are next the Sun, the Centre of the Planetary System. An Account of their Motion and *Phænomena* to an Eye placed at the Earth, is as follows.

1. The *Periodical Times* of their Motion thro' the Ecliptic are plainly equal; which is contrary to what appears in the Motion of the Superior Planets: And their Progress through the Ecliptic is measured by the Motion of the Sun; so that if the apparent Motions of the *Sun*, *Venus*, and *Mercury*, be considered for many Years together, they will appear to run through the Zodiac in an equal Space of Time.

The Reason of this Diversity between the Superior and Inferior Planets, is not from any real *Difference* in their Motions, but arises solely from the different Position of this Earth which we inhabit.

All the Planets are circulated round the *Sun* in one and the same Ratio; the *more distant* requiring a longer time for their Revolution, than those which are *more near*. Thus the Earth being farther from the Sun than *Venus*, is a longer time in moving round him; and *Venus* than *Mercury*: And to an Eye placed in the Sun, the Motions of the Inferior and Superior Planets would appear alike uniform and proportionable to their Distance. But to an Eye at the Earth, as the *Superiors*, containing our Orbit within theirs, will appear to move sometimes *slower*, and sometimes *swifter*; now to be *stationary*, and now *retrograde*; so the Motions of the *Inferiors* will appear to depend upon the Motion of the Sun, to whom they are so nearly joined as it were; and to us, that are in an Orbit so far without them, will appear to be equal to the Motion of that great Luminary.

2. The *Sun*, *Venus*, and *Mercury*, singly considered, are each affected with such an Inequality of Motion, that it is very rare for them all three, or indeed for any two of them, to agree in the same Degree of Velocity.

Indeed, if *Venus* and *Mercury* had no Motion of their own round the Sun, but kept an invariable Position with regard to him, it were reasonable to suppose, that they should move on almost equably, as the Sun doth. But since that *apparent Motion*, with which they annually run through the Zodiac, is derived from a double Fountain, *viz.* from their own proper Motion round the Sun, which is not very unequable in itself; and from the Position of the Earth, which is continually various and changeable, in an Orbit that is without theirs; 'tis not



strange that each of the *Inferior Planets* should appear to move unequally, and to go sometimes slower, and sometimes faster, by turns.

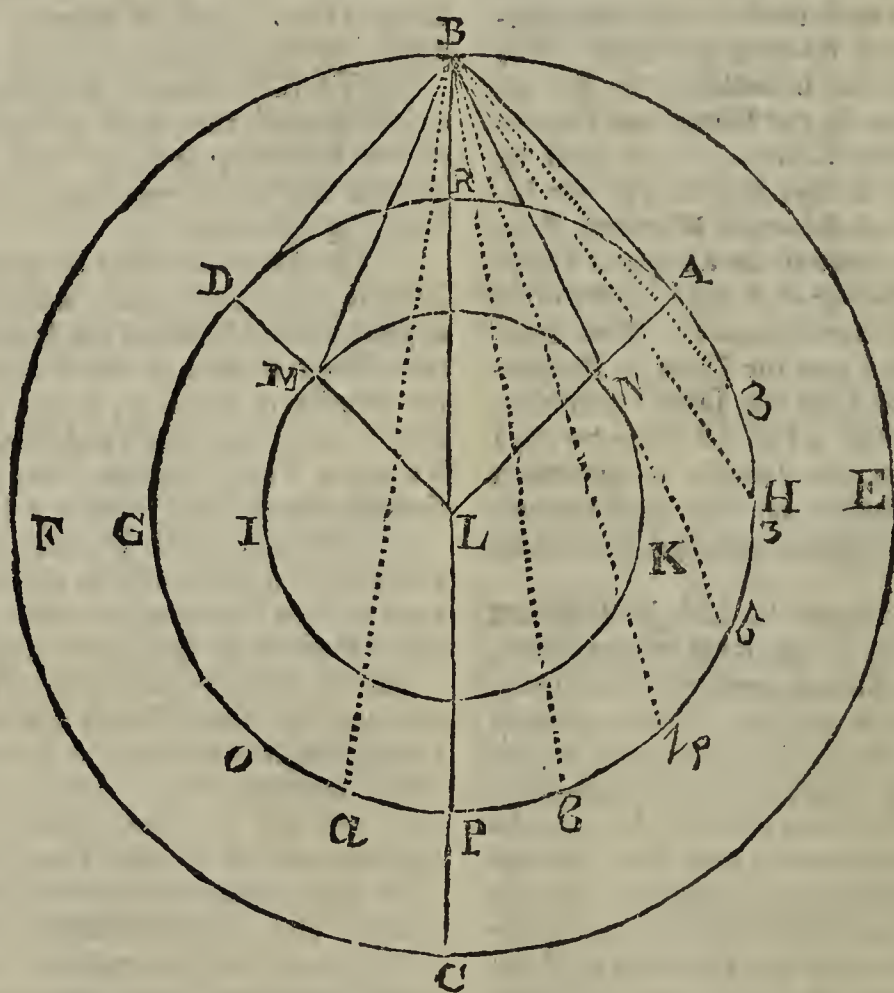
3. Although the Periodic Times of *Venus* and *Mercury* in the *Ecliptic* through the Course of the Year, are thus accurately equal to one another, yet the Periodic Times of *Venus*, if reckon'd from any one present Position to the Sun, to a like subsequent one, if compared with the Periodic Times of *Mercury* in a like Position, will appear to be of a much longer Length.

For this Inequality of the Periodic Times, according to the unequal Distance from the Sun, is agreeable to the established Law of the heavenly Bodies: For *Venus* is nearer to the Sun than the Earth, and *Mercury* than *Venus*. Wherefore the Periodic Times of *Venus*, considered in themselves, and with regard to the fix'd Stars, are not a little shorter than those of the Earth; and those of *Mer-*

*cury* shorter than the Periodic Times of *Venus*. And though these Motions should be considered by a Spectator at the Earth, he would find in them the same Inequality: For the Motion of *Mercury* will be sooner, and oftner *more swift*, than that of the Earth; and therefore their Periodic Times must be unequal.

4. These Inferior Planets are never either in *Opposition* or in *Quadrature* to the Sun; but always more near to him, than to occasion those *Phænomena*: For *Mercury* goes no farther from the Sun than about 28 Degrees, and *Venus* not above 48 Degrees; sometimes to the Eastward, and sometimes to the Westward. That neither of these Planets can come to be in *Quadrature*, much less in *Opposition* to the Sun, will be plain from the following Scheme.

Let the Circle *BFCE* be the Earth's Annual Orbit; *ADGH* the Orbit of *Venus*; and *NMK*



that of *Mercury*. The greatest Elongation of *Venus* from the Sun, is determined by the Acute Angle *LBA*, made by the Line *BL* drawn from the Sun to the Earth, and the Line *BA*, which is a Tangent, to the Orbit of *Venus*. In like manner the Acute Angle *LBN* will determine the greatest Elongation of *Mercury* from the Sun. Now the Quantity of these Angles, in a Proportion assign'd, may be had from the Semidiameters of the Orbits being found by Observation, and by Trigonometrical Calculation: Or, indeed, they will be discover'd by Observation of the greatest Elongations themselves.

5. Our modern Astronomers have observ'd, That *Venus* appears *bigger* when she begins to recede from the Sun towards the East, and when she is yet but a little Distance from him; but, on the contrary, that she appears *less* in her Approach towards the Sun, and when she comes pretty near him: whereas, when she recedes from the Sun towards the West, then she appears *less*; but when she approaches towards him again, she again appears *larger*. And the same things have been observed of *Mercury*, by the use of long and good Telescopes.

These *Phænomena* have quite overturn'd the *Ptolemaic System* of the Heavens, and may be accounted for thus: Since all the Planets, as well as the Earth, are Opake, Scabrous, and Spherical Bodies, reflecting every way from them the Rays of the Sun falling upon them; 'tis plain, that that Hemisphere of any Planet only, which is turned towards the Sun, will be enlightened; the other Half of it remaining in Darkness. And, since also an Observer here can only see that Half or Hemisphere of any Planet, which is obverted, or turned towards the Earth, where he stands; if it be considered *what Part* of *Venus* is enlighten'd by the Sun in her different Position or Situation towards him, and *what Part* is seen by an Eye at the Earth in its Annual Orbit *BFCE*; (See the preceding Fig.) it will be plain that *Venus* must appear *least* to us when she is in *R*; because, tho' she be then the most near to us possible, yet her obscure Hemisphere being towards us, there will be but very little of her enlighten'd part seen: But when she comes into the Position *D*, then some part of her illuminated Disk will be turned towards the Eye in *B*; but a much greater



ter part of her obscure or dark Hemisphere. And since she is of a Spherical Figure, which to a distant Eye appears as a Plane, 'tis clear that the illuminated part of her Disk must appear in the Form of Horns, turned from the Sun, or towards the West. And this is her Appearance when *Venus* is our *Morning-Star*, as she is commonly called. But this Planet moving on in her Orbit to *G*, very near one half of her illuminated Disk will become visible to the Eye at *B*; and, consequently, she will then appear in the Form of an Half-Moon. When she comes into the Position *O*, more than half of her enlighten'd Hemisphere will be visible, and so she will appear *Gibbose*: And when she arrives at that part of her Orbit which *P* designs, to an Eye at *B*, as before, she will appear, as we say of the Moon, at *Full*; that is, all her illuminated Disk will be visible. The same kinds of *Phases Venus* will put on, as she moves forward in her Orbit through *Q, H, A*; that is, in *Q* she will be *Gibbose*; in *H* like an Half-Moon; in *A* horned again; but her Horns will be turned a contrary way to what they were in *D*; that is, now to the Eastward, but still from the Sun: And this is her Appearance when she is the *Evening-Star*.

The same kinds of *Phænomena* belong to *Mercury*; respect being had to his particular Orbit and Period of his Revolution.

But here we must take care that we be not deceived by the general Consideration of her Phases only, so as to think that *Venus* will always appear brightest and largest in *P*, or in *Q* or *O*. The Appearance which *Venus* may seem to have in her *Opposition*, as it may be called in *P*, will be quite alter'd by her coming as near as she can to the Sun: And as to the Places *O* and *Q*, tho' *Venus* will shine with near a full Face, yet she will be then so far from the Earth, that her Distance from us will more than compensate for the Quantity of her Light: Wherefore you may expect to see her appear most bright and splendid when she is in *D* or *A*. For suppose her to move from *Q* to *H*, then will some part of her lucid Hemisphere be turned from us in *B*, and so cannot be seen; and yet the remaining luminous Part comes still nearer to the Earth. And since her *Shining*, or apparent Light, increases in a Duplicate Ratio, or as the Square of her Distance from us diminishes, her Light will be much more increased by her Approach to the Earth, than it will be lessened by our seeing less of her illuminated Disk. So also suppose her to move from *H* to *A*, or yet farther on; here still the Quantity of her illuminated Part decreases, but the duplicate Increase of her Approach to the Earth will yet make her Splendor increase. But between *A* and *R* the Decrease of her visible Light will be greater than what her Access towards the Earth can compensate; and so her Light will continually diminish more and more, 'till she will set *Heliacally*, and so become invisible. Thus also while the Planet is moving from *P* towards *Q*, her Approach towards the Earth in *B* is inconsiderable, in comparison of the Parts of her illuminated Disk, which will be turned away from us; and consequently she will appear more obscurely in *Q* than she will in *P*: But between *Q* and *H*, and so towards *A*, her Approach to the Earth will very much increase her Splendor, tho' less and less of her lucid Disk become still visible. And from the whole it is plain, that while she is moving in the Arch *HA*, she will appear brightest and largest.

6. The greatest Elongations of *Venus*, whether towards the East or West, are unequal, and must

be express'd by an unequal Number of Degrees. And the same thing is also true of *Mercury*.

This *Phænomenon* hath a double Original or Cause; for it depends on the Excentricity of the Orbits both of *Venus* and of the Earth. For if the Distance *LA* (in the former Fig.) of *Venus* from the Sun; or if *LB*, the Distance of the Earth from the Sun, be unequal: it cannot be, but that the Angle *LBA*, in the Triangle *LBA*, which is called the greatest Elongation, must also be unequal: And indeed both those Lines are subject to such an Inequality.

7. The same *Directions, Stations, and Retrogradations*, which we observe in the Course of the Superior Planets, are found to belong to these Inferiors, and with the same Circumstances of Change.

For suppose the Earth, as before, in *B*, and immoveable there, and the Planet in *P*; 'tis then plain, that while the Planet moves Easterly from *P* to *Q*, to an Eye placed in *B*, it must appear *Direct*, or to move *in Consequentia*, as they speak; that is, according to the Order of the Signs: And so it will appear to do till it come to *A*. But yet, because the Arches *Pβ, βγ, δε, εζ*, are equal, but the Angles that they subtend at *B* are unequal; therefore the Planet will appear to move unequally through those Arches: For it will seem to move swiftest about *P*, and still slower and slower, the nearer it comes to *A*: And there it will begin to appear *Stationary*, or not to move at all: And while it runs over the Arch *AR*, it will meet with the former Lines *Bζ, Bε, Bδ, Bγ*, and therefore must appear to be *Retrograde*, or to move backward, or *in Antecedentia*, as the Term is; that is, contrary to the Order of the Signs. Which apparent Retrograde Motion will continue till the Planet come to *D*; and then it will begin to be, or rather appear to be, *Stationary* again; and so on, as before.

And should you suppose the Earth, as it is, moving in the Orbit *BFC E*; when the Planet moves faster than the Earth, it will even then appear to be *Direct*; when at an equal Pace with it, *Stationary*; and when slower than it, it will appear *Retrograde*, as before; tho' the Times and Places of these *Directions, Stations, and Retrogradations* will not be the same, as if the Earth indeed stood still: As will easily be understood by a little Consideration of the Figure above; or by what is said on this Head under the Words *Superior Planets* in this Vol. II.

8. The Planes of the Orbits of the *Inferior* Planets being inclined to that of the *Ecliptick*, the same *Phænomena* will arise from thence in kind, as in the same Case of the *Superiors*; only it is worth taking notice of, that the Plane of the Orbit of *Mercury* making an Angle with that of the *Ecliptick* of very near seven Degrees, he hath the greatest Latitude of any of the Planets; and therefore will be subject to the greatest Anomalies of Latitude.

9. It is sometimes, but rarely, observ'd of these two *Inferior* Planets, that their Bodies being interposed between us and the Sun, they appear like *Spots* in the Plane of his Disk.

And 'tis plain, that this will happen whenever their Conjunction with the Sun falls on or near either of the Nodes of their Orbits: Just as the Moon appears to eclipse or hide part of the Sun's Face, when her Conjunction happens in or near the Nodes of her Orbit.

INFERNAL-STONE, or *Perpetual Caustick*, is a Chymical Operation, whereby Silver is rendred *Caustick* by the Salts of Spirit of Nitre.



'Tis thus made;

Diffolve in a Phial any Quantity of Silver in thrice its Weight of Spirit of Nitre; and then in a Sand-heat evaporate  $\frac{2}{3}$  of the Moisture: The Remainder put into a good large *German* Crucible, which place over a gentle Fire; let the Matter alone, and heaving, till at last it sinks quietly to the Bottom, then increasing the Fire a little, 'twill turn into an Oil; and as soon as you perceive it to be so, it must immediately be poured into an Iron-Mold, purposely made for it, that is a little oil'd and greas'd, where it will presently coagulate and harden. After 'tis taken out, it must be kept in a Phial well stop'd. 'Tis a great *Cautick*, and will last for ever, if it be kept from the Air. Some make them of Copper, but those are not so good as these.

INFIMUS VENTER: see *Abdomen*.

INFINITE, is that which has no Bounds, Terms, nor Limits.

INFINITE QUANTITY. *Of the several Species of Infinite Quantity, and of the Proportions they bear one to the other, the learned Mathematician Capt. Halley, in Philosoph. Transf. N. 193. gives the following Account:*

That all Magnitudes infinitely great, or such as exceed any assignable Quantity, are equal among themselves, tho' it be vulgarly received for a Maxim, is not yet so common as it is erroneous; and the Reason of the Mistake seems to be, That the Mind of Man coming to contemplate the Extensions of what exceeds the Bounds of its Capacity, and of which the very Idea does include a Negation of Limits; it comes to pass that we acquiesce generally, and it suffices to say, such a Quantity is *Infinite*.

But if we come more nearly to examine this Notion, we shall find, that there are really besides *Infinite Length*, and *Infinite Area*, no less than three several Sorts of *Infinite Solidity*; all of which are *Quantitates sui generis*, having no more Relation or Proportion the one to the other, than a Line to a Plane, or a Plane to a Solid, or a Finite to an Infinite; but that among themselves each of these Species of *Infinities* are in given Proportions, is that which is to be made plain.

But first, *Infinite Length*, or a Line infinitely long, is to be considered, either as beginning at a Point, and so infinitely extended one way, or else both ways from the same Point; in which case the one, which is a beginning *Infinity*, is the one half of the whole, which is the Sum of the beginning and ceasing *Infinity*, or of *Infinity à parte ante*, and *à parte post*, which is analogous to Eternity in Time or Duration, in which there is always as much to follow as is past from any Point or Moment of Time: Nor doth the Addition or Subduction of finite Length or Space of Time alter the Case, either in Infinity or Eternity, since both the one and the other cannot be any Part of the Whole.

As to *Infinite Surface* or *Area*, any Right Line infinitely extended both ways on an infinite Plane, does divide that infinite Plane into equal Parts, the one to the Right, and the other to the Left of the said Line: But if from any Point in such a Plane, two Right Lines be infinitely extended, so as to make an Angle, the infinite Area, intercepted between those infinite Right Lines: is to the whole infinite Plane :: as the Arch of a Circle, on the Point of Concourse of those Lines as a Centre, intercepted between the said Lines: is to the Circumference of the Circle; or as the Degrees of the Angle, to the 360 Degrees of the Circle.

For Example:

Two Right Lines meeting at a Right Angle, do include, on an infinite Plane, a quarter Part of the whole infinite Area of such a Plane.

But if so be two parallel infinite Lines be supposed drawn on such an infinite Plane, the Area intercepted between them will be likewise infinite; but at the same time will be infinitely less than that Space which is intercepted between two infinite Lines that are inclined, tho' with never so small an Angle; for that in the one Case the given finite Distance of the Parallel Lines, diminishes the Infinity in one Degree of Dimension; whereas in a Sector there is Infinity in both Dimensions; and consequently the Quantities are the one infinitely greater than the other, and there is no Proportion between them.

From the same Consideration arise the three several Species of infinite Space or Solidity, as has been said: For a Parallelopiped or a Cylinder infinitely long, is greater than any finite Magnitude, how great soever; and all such Solids supposed to be formed on given Bases, are as those Bases, in proportion to one another: But of these, three Dimensions are wanting, as in the Space intercepted between two parallel Planes infinitely extended, and at a finite Distance; or with infinite Length and Breadth with a finite Thickness; all such Solids shall be as the given finite Distances one to another; but these Quantities, tho' infinitely greater than the other, are yet infinitely less than any of those wherein all the three Dimensions are infinite. Such are the Spaces intercepted between two inclined Planes infinitely extended; the Space intercepted by the Surface of a Cone, or the Side of a Pyramid likewise infinitely continued, &c. of all which, notwithstanding the Proportions one to another, and to the vast Abyss of infinite Space, (wherein is the *Locus* of all things that are or can be; or to the Solid of infinite Length, Breadth, and Thickness taken all manner of ways) are easily assignable. For the Space between two Planes: is to the whole :: as the Angle of those Planes: to the 360 Degrees of the Circle.

As for Cones and Pyramids, they are as the Spherical Surface intercepted by them, is to the Surface of the Sphere; and therefore Cones are as the Versed Sines of half their Angles to the Diameter of the Circle. These three Sorts of *Infinite Quantity* are analogous to a Line, Surface, and Solid, and after the same manner cannot be compared, or have no Proportion the one to the other.

Besides these, there are also several other Species of *Infinite Quantity*, arising from the Contemplation of Curves and their Asymptotes, which he leaves to the Speculation of the learned Mathematicians.

INFINITELY *Infinite Fractions*, a Term used where all the Fractions, whose Numerator is 1, are together equal to an Unit; and hence it is deduced, that there are not only *Infinite Progressions*, or *Progressions in infinitum*, but also infinitely farther than one kind of Infinity: That these *Infinately Infinite Progressions* are notwithstanding computable, and to be brought into one Sum, and that not only finite, but into one so small, as to be less than any assignable Number: That of infinite Quantities, some are equal, others unequal; that one infinite Quantity may be equal to two, three, or more Quantities, whether infinite or finite.

INFINITE Series. Under the Word *Series* I shew that this Method of *Infinite Series* took its Rise from the Arithmetick of Infinities, and hath been pursued with wonderful Sagacity and Penetration by



by several of our excellent modern Algebraists. The Use of this Method in the Extraction of Roots is there shewn from the ingenious Mr. *Ralphson* and Mr. *Ward*: What here follows is more universal, and is from *Parsons's* and *Wastell's* Arithmetick.

Let  $\left\{ \begin{array}{l} A = \text{to the Absolute Numb. in any Equation.} \\ n = \text{to the Exponent of the highest Power.} \\ x = \text{to Root or Quantity sought.} \\ N = \text{any known Number taken at pleasure.} \\ n = \text{an unknown Number.} \\ 1, p, q, r, s, \&c. = \text{to the respective Coefficients of the given Equation.} \end{array} \right.$

Then will  $N + n = x$ ; and

$$\pm 1 \times x^n \pm p \times x^{n-1} \pm q \times x^{n-2} \pm r \times x^{n-3} \pm, \&c. = A, \text{ represent any Equation whatsoever.}$$

And because  $N + n$  is supposed equal to  $x$ , such a general Equation may be thus expressed:

$$\pm 1 \times \overline{N + n}^n \pm p \times \overline{N + n}^{n-1} \pm q \times \overline{N + n}^{n-2} \pm r \times \overline{N + n}^{n-3} \pm, \&c. = A.$$

But to bring this into a *Series*, it is necessary first to prove, That every Power raised from a Binomial, (without regarding the Coefficients) consists, or is composed of two Ranks or *Series* of Powers; one increasing from  $n^{n-n}$ , or 1, to  $n^n$ , and the other decreasing from  $N^n$  to  $N^{n-n}$  or 1; and each Member in one is multiplied into its corresponding Member in the other respectively; as may appear thus:

$$\overline{N + n}^n = \left\{ \begin{array}{l} NN \\ 2 Nn \\ n n \end{array} \right\} = \left\{ \begin{array}{l} N^n \times n^{n-n} \text{ or } 1. \\ N^{n-1} \times n^{n-1} \text{ twice.} \\ N^{n-n} \times n^n \end{array} \right.$$

$$n = \frac{A \pm 1 \times N^n \pm p \times N^{n-1} \pm q \times N^{n-2} \pm r \times N^{n-3}, \&c.}{1 \times \underset{n}{N^{n-1}} \pm p \times \underset{n-1}{N^{n-2}} \pm q \times \underset{n-2}{N^{n-3}} \pm r \times \underset{n-3}{N^{n-4}}, \&c.}$$

Which Theorem exhibits all possible particular ones, for extracting of Roots, according to the first sort of Mr. *Ralphson's*; agreeing exactly with them, as will be found on Tryal; always remembering that

$$x = \frac{A \pm 1 \times \underset{n-1}{N^n} \pm p \times \underset{n-2}{N^{n-1}} \pm q \times \underset{n-3}{N^{n-2}} \pm r \times \underset{n-3}{N^{n-3}}, \&c.}{1 \times \underset{n}{N^{n-1}} \pm p \times \underset{n-1}{N^{n-2}} \pm q \times \underset{n-2}{N^{n-3}} \pm r \times \underset{n-3}{N^{n-4}}, \&c.}$$

Which gives us all those of the *second sort* universally: But in this Case the Signs both in the Dividend and Divisor will be the same as in the given Equation respectively: As likewise it may be proper to take notice, that if any Term be wanting in the Equation, the same must be omitted in either Theorem respectively.

Now from either of these *two Generals*, to deduce any *particular Theorem*, for finding the Root of any *given Equation*; we need only consider,

Again,

$$\overline{N + n}^n = \left\{ \begin{array}{l} NNN \\ 3 NNn \\ 3 Nnn \\ nnn \end{array} \right\} = \left\{ \begin{array}{l} N^n \times n^{n-n} \\ N^{n-1} \times n^{n-2} \\ N^{n-2} \times n^{n-1} \\ N^{n-n} \times n^n \end{array} \right\} \text{ thrice}$$

And so it will always be *ad Infinitum*. Q. E. D. Hence these two *Corollaries*.

#### COROLLARY I.

That the Coefficient of the second Term in any Power raised from a *Binomial*, is always =  $n$  the Exponent of the highest Power.

#### COROLLARY II.

That the Root or Side of  $n^n$  the unknown Quantity, is always multiplied into the second Term of the known.

Now from the *latter*, it is evident we are (in this Case) but to make use of the two first Members of the Power of such *Binomial*; and by the first we may express the Coefficient of the second Term, by  $n$  the Exponent of the Power: Therefore the former Equation will now stand thus;

$$\pm 1 \times \overline{N \pm n}^n \pm \underset{n}{n} \overline{N \pm n}^{n-1} \pm p \times \overline{N \pm n}^{n-1} \pm \underset{n-1}{N^{n-2}} \\ n \pm q \times \overline{N \pm n}^{n-2} \pm \underset{n-2}{N^{n-2}} n \pm r \times \overline{N \pm n}^{n-3} \pm \underset{n-3}{N^{n-3}} n \pm, \&c. = A.$$

Now to find the Value of  $n$ , or the unknown Quantity, it is plain, that those Members into which it is multiplied, will be the Divisor with the same Signs, and the others the Dividend, but with contrary Signs, as being to be transpos'd to the other side of the Equation: Therefore first,

the Signs in the Dividend must be contrary to those in the Equation, and in the Divisor the same respectively.

But  $N + n = x$ : Therefore secondly,

that  $N^{n-n} = 1$ , or  $\frac{N^n}{N^n} = 1$ , that Unity will neither multiply nor divide; as also that  $\underset{n-n}{N^n} = 0$ , or  $\underset{n}{N^n} \cdot \underset{n}{N^n} = 0$ , and any Quantity, multiply'd into 0, is = 0; and when either Case happens (which always will, except where the last Term is wanting) the *Theorem* is determined.



Therefore,

Suppose any Equation, as

By the first General Theorem,

By the second General Theor.

$x^2 = A.$	Then we shall find $n \equiv$	$\frac{A - N^2}{2N}$	$\equiv$	$\frac{A + N^2}{2N}$
$x^3 = A.$		$\frac{A - N^3}{3N^2}$		$\frac{A + 2N^3}{3N^2}$
$x^4 = A.$		$\frac{A - N^4}{4N^3}$		$\frac{A + 3N^4}{4N^3}$
$x^2 \pm p x = A.$		$\frac{A - N^2 \mp p N}{2N \pm p}$		$\frac{A + N^2}{2N \pm p}$
$-x^2 \pm p x = A.$		$\frac{A + N^2 - p N}{-2N + p}$		$\frac{A - N^2}{-2N + p}$
$x^4 \pm p x^3 = A.$		$\frac{A - N^4 \mp p N^3}{4N^3 \pm 3p N^2}$		$\frac{A + 3N^4 \pm 2p N^3}{4N^3 \pm 3p N^2}$
$x^3 \pm p x^2 \pm q x = A, \&c.$		$\frac{A - N^3 \mp p N^2 \mp q N}{3N^2 \pm 2p N \pm q}$		$\frac{A + 2N^2 \pm p N^2}{3N^2 \pm 2p N \pm q}$

And after the same manner for any Equation whatsoever.

Thus having the particular Theorem, the Application in either Case is as follows:

Let  $N$  be any Number taken at Pleasure, as before.

$T$  be = Theorem, in which  $N$  must always be of its last Value found.

Then the Procefs will be of the

First General Theorem.

$N$  the 1st.  $\pm T = N$  the 2d. Then  
 $N$  the 2d.  $\pm T = N$  the 3d. Then  
 $N$  the 3d.  $\pm T = N$  the 4th. Then  
 $N$  the 4th.  $\pm T = N$  the 5th, &c.

Second General Theorem.

$T = N$  the 2d. Then  
 $T = N$  the 3d. Then  
 $T = N$  the 4th. Then  
 $T = N$  the 5th, &c.

Some of which Values of  $N$  will terminate in the true Root sought, if it have one: But if it be a Surd; then the Value of  $N$  will proceed into an Infinite Series, but may be prosecuted nearer the Truth than any assignable: Which Series, each Operation will proceed in Number of Places, in a Geometrical Progression; whose first Term is 1, and Ratio = 2, viz. First 1, then 2, then 4, then 8, then 16, then 32, &c. Places.

It is likewise observable, That the first General Theorem converges, by finding out a Number to be added to, or subtracted from the last Value of  $N$ , (as it shall be affected with  $+$  or  $-$ ) until  $N$  be =  $x$  sought. So the last converges by  $N$  itself, whose Value, at each Operation, shall grow nearer and nearer, until it be = to  $x$  sought.

We may also take notice, that though  $N$  be assumed never so far from the true Root, yet it will converge to it by renewing the Operation. But the Work may be much shortned, in case we point the given Equation (if it will admit of it) both in the absolute Number and Coefficients, according to their respective Degrees of Affection: And take first 1, then 2, then 4, &c. of those Points, (from the first) each Operation: For it is evident, the Coefficients increase in their Powers, as the highest unknown Term decreases; therefore the absolute Number is of the same Power with the highest unknown Quantity.

One Instance may be sufficient to explain it: Suppose therefore this Cubic Equation were to be pointed;

$$\text{Viz. } xxx + 25xx + 836x = 53297$$

$$\text{Or } xxx + pxx + qx = A.$$

Then it would be  $xxx + 25xx + 836x = 53297$   
 For the absolute Number is a Cube  
 Coefficients  $q$  a Square } and are pointed  
 $p$  a Lateral } accordingly.

And the like Method for any other Equation, where it will admit of it.

Now to apply this last, we are to take  
 the First Operation  $xxx + 2xx + 8x = 53$   
 Second Operation  $xxx + 25xx + 836x = 53297$

And consequently the Value of the Coefficients as well as the absolute Number alters, so long as there are Punctations.

But by a few Numerical Operations, the said Notification, as well as the Method of the Procefs of each Theorem, will be further illustrated: Therefore,

1. Suppose  $xx = 2 = A$ . Seek  $x$  by the first General Theorem.

$$\text{Then } n = \frac{A - N^2}{2N} = T, \text{ and take } N = 1;$$

Therefore  $1 + T (=, 5) = 1, 5 = N$  the 2d.  
 $\therefore 1, 5 - T (=, 0, 83) = 1, 417 = N$  the 3d.  
 $\therefore 1, 417 - T (=, 0, 02783) = 1, 414217 = N$  the 4th.  
 $\therefore 1, 414217 - T (=, 0, 00003437622) = 1, 414213562378 = N$  the 5th =  $x$ .

2. Suppose  $xx = 2 = A$ . Seek  $x$  by the second General Theorem.

$$\text{Then } x = \frac{A + N^2}{2N} = T, \text{ and take } N = 1, \text{ as before.}$$

Therefore  $T = 1, 5 = N$  the 2d.  
 $\therefore T = 1, 416 = N$  the 3d.  
 $\therefore T = 1, 414215 = N$  the 4th.  
 $\therefore T = 1, 414213562373 = N$  the 5th.  
 $= x.$



By which it is evident, *First*, That both Theorems amount to the same thing; the Difference being only in the last Figure, which would be corrected the next Operation. *Secondly*, That  $x$  will proceed into an *infinite Series*, if a Surd. *Thirdly*, That each Operation gives double the Number of Figures of the last.

3. Suppose  $x x x x = 2839,8241 = A$ . Seek  $x$  by Theorem 1.

$$\text{Then } x = \frac{A - N^4}{4 N^3} = T, \text{ and take } N = 10.$$

Therefore  $10 - T (= -3) = 7 = N$  the 2d.

$$\therefore 7 + T (= +4) = 7,4 = N \text{ the 3d.}$$

$$\therefore 7,4 - T (= -1) = 7,3 = x, \text{ the true Biquadratic Root fought.}$$

4. Suppose  $x x x x = 2839,8241 = A$ , as before. Seek  $x$  by the second Theorem.

$$\text{Then } x = \frac{A + 3 N^4}{4 N^3} = T, \text{ and take } N = 5.$$

Therefore  $T = 5,6 = N$  the 2d.

$$\therefore T = 8,2 = N \text{ the 3d.}$$

$$\therefore T = 7,4 = N \text{ the 4th.}$$

$$\therefore T = 7,3 = N \text{ the 5th} = x = \text{true Root fought.}$$

From which two last Examples it appears; *First*, That *either Theorem* will find the *true Root*, if it have one. *Secondly*, That it *matters not*, whether  $N$  be taken *above* or *below* the Root, nor how far from it.

5. Suppose  $x x + 587 x = 987459$  or  $x x + p x = A$ . Seek  $x$  by *Theor. 1. (i. e.)*  $n = \frac{A - N^2 - p N}{2 N + p} = T$ .

Because of the Punctations we are to take,

$$\begin{array}{l} 1. \text{ Operation } x x + 5 x = 98 \\ 2. \quad \quad \quad x x + 58 x = 9874 \\ 3. \quad \quad \quad x x + 587 x = 987459 \end{array} \left. \vphantom{\begin{array}{l} 1. \\ 2. \\ 3. \end{array}} \right\} \begin{array}{l} \text{And suppose} \\ N = 8. \end{array}$$

Therefore  $8 - T (= -, 2) = 78 = N$  the 2d.

$$\therefore 78 - T (= -3,4) = 746 = N \text{ the 3d.}$$

$$\therefore 746 - T (= -3,34) = 742,66 = N \text{ the 4th.}$$

$$\therefore 742,66 - T (= -, 012689) = 742,647311 = x \text{ fought.}$$

6. Suppose  $x x - 20 x = 53482$ , or  $x x - p x = A$ . Seek  $x$  by the second General Theorem.

$$\text{Then } x = \frac{A + N^2}{2 N - p} = T, \text{ and take } N = 250$$

Therefore  $T = 241 = N$  the 2d.

$$\therefore T = 241,4 = N \text{ the 3d.}$$

$$\therefore T = 241,475 = N \text{ the 4th.}$$

$$\therefore T = 241,477860 = N \text{ the 5th.} = x \text{ fought.}$$

From these two last it is plain, *First*, That there is no absolute Necessity for Punctation. *Secondly*, That Punctation does nevertheless *shorten* the Work, where it can be done.

But I hope I have said enough to make the whole Matter, as well as the Manner, of Proceeding plain and easy to the meanest Capacity: And

tho' I have given *Numerical Examples* no farther than an *affected Quadratic*, yet 'tis the same to any *Degree* of Power or Affection whatsoever; regard being had to its proper and particular Theorem, deduc'd from either of the general ones.

INFINITESIMALS (as some Writers call them) are such Quantities as are supposed to be infinitely small.

INFINITIVE-MOOD, in Grammar, is when a Verb is used so as to determine neither any particular Person nor Number.

INFLAMMATIO: see *Pblegmone*.

INFLATION, is the Distention of a Part from flatulent Matter.

INFLECTION (in Opticks) is a multiplicate Refraction of the Rays of Light, caused by the unequal Density of any Medium, whereby the Motion or Progress of the Ray is hinder'd from going on in a Right Line, and is inflected or deflected by a Curve, saith the ingenious Dr. *Hook*, who first took notice of this Property in his *Micrography*, p. 217. And this he saith differs both from Reflection and Refraction, which are both made at the Superficies of the Body, but this in the middle of it within.

Sir *Isaac Newton*, as you will find under the Word *Light*, discovered also by plain Experiment this Inflection of the Rays of Light; and Mr. *de la Hire* saith he found, That the Beams of the Stars being observed in a deep Valley, to pass near the Brow of an Hill, are always more refracted than if there were no such Hill, or the Observations were made on the Top thereof; as if the Rays of Light were bent down into a Curve, by passing near the Surface of the Mountain.

INFLECTION-POINT of any Curve, in Geometry, signifies the Point or Place where the Curve begins to bend back again a contrary way: As for instance;

When a Curve-Line, as *AFK*, is partly Concave and partly Convex towards any Right-Line, as *AB*, or towards a fix'd Point, then the Point *F*, which divides the Concave from the Convex Part, and consequently is at the Beginning of one, and End of the others, is called the Point of *Inflection*, as long as the Curve, being continued in *F*, keeps its Course the same; but 'tis called the Point of *Retrogression*, when it inflects back again towards that Part or Side from whence it took its Original. See the next Figure save one.

Before the Theory of this Inflection and Retrogression of Curves can be understood, a certain Principle must be explain'd, which is this, as communicated by Mr. *Ditton*.

Whatsoever finite Quantity (or if it be a Fluxion 'tis all one) goes on continually increasing or decreasing, it cannot change from a positive to a negative Expression, or from a negative to a positive one, without first becoming equal to an Infinite, or to Nothing: It is equal to Nothing, if it does continually decrease, and equal to an Infinite, if it does continually increase.

To illustrate this, Let there be two Circles touching one another in the Point *E*, their Diameters *AE* and *EI*, lying in one and the same Right-Line. Let *AE* or *EI* be  $= d$ . Let the Distance between the Extremity *A*, and any Ordinate in either of the Circles be  $= x$  perpetually. I consider now, what will be the Expressions of the Lines intercepted between *E* the Point of Contact of the Circles; such as are the Lines *EB* and *EF* intercepted between *E* and the Ordinates *CB* and *GF*. 'Tis certain therefore, that taking a Point, as *B*, any where



where between  $A$  and  $E$ , that then the Expression of the intercepted  $BE$  is  $d - x$ ; but taking a Point, as  $F$ , between  $E$  and  $I$ , the Expression of the intercepted  $EF$  shall be  $x - d$ . For  $AB$ , or  $AF$ , being taken for  $x$  indifferently, the Values of the intercepted Lines will appear with this Change of Signs.

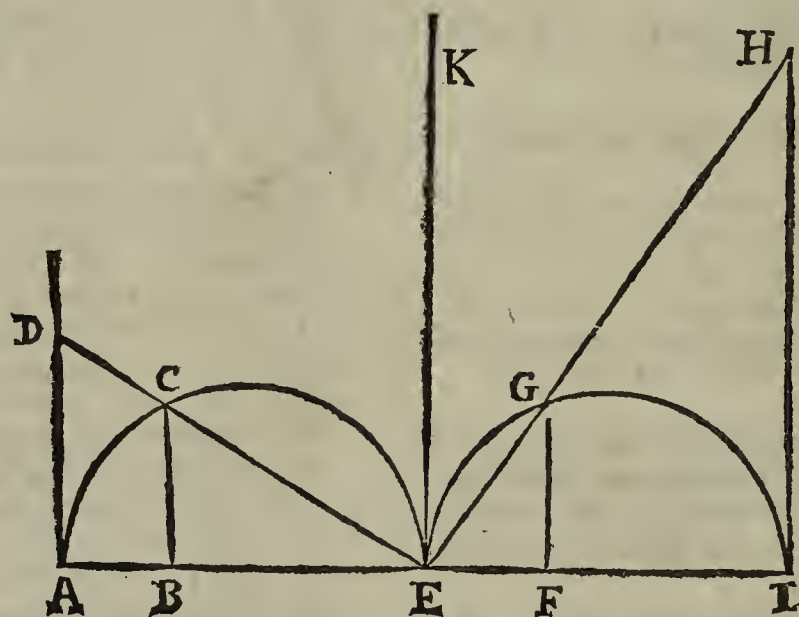
In one Case therefore the Expression is positive, in the other negative. But as the Points  $B$  or  $F$  approach to  $E$ , the Quantities  $BE$  and  $EF$  decrease continually, and at the Point  $E$  are equal to nothing.

So that it is plain, that there is no passing from a positive to a negative Expression, in this case of a Quantity continually decreasing, without passing thro' nothing. For the other part,

Let us consider the Tangents (as  $DA$  or  $HI$ ) cut off by Lines continually drawn from  $E$  the Point of the Circles Contact. If  $CB$ , or  $GF$ , be put equal to  $y$ , the Expression of any such Tangent will be  $\frac{y d}{d - x}$ , or  $\frac{y d}{x - d}$ , according as we take it on

the one or the other Side of the Point  $E$ ; in one Case therefore 'tis positive, in the other negative. But as the Points  $B$  or  $F$  approach to  $E$ , the Tangents  $DA$  and  $HI$  increase continually, and at the Point  $E$  they become infinite: Therefore a Quantity that continually increaseth, cannot pass from a positive to a negative Expression, without being infinite.

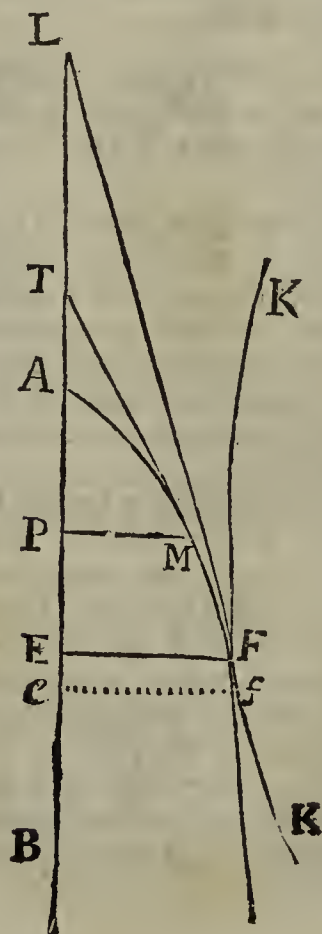
All this is universally true, whether it be a finite Quantity or a Fluxion that we consider. There is



no changing from Positive to Negative, without passing thro' Nothing or Infinite.

Applying this therefore to Fluxion, it will follow from hence, That the Fluxion of a Quantity, that expresses a *Maximum* or a *Minimum*, must be equal to Nothing or to Infinite. And upon this Foundation we may now easily proceed to the Speculation of the Points of *Inflection* and *Retrogression*:

In order to find a general Theorem to assist us in this Matter, let us consider the Curve  $AFK$ ,



whose Diameter is the Right-Line  $AB$ ; and its Ordinates  $PM$ ,  $ef$ , parallel to one another. If thro' the Point  $F$  be drawn the Ordinate Applicate  $EF$ , together with the Tangent  $FL$ ; and from any other Point, as  $M$ , on the same Side with  $AF$ , he draws the Ordinate Applicate  $MP$ , as likewise the Tangent  $MT$ : It is evident,

1. In these Curves that have a Point of *Inflection*, that the Abscissa  $AP$  increaseth continually, and that the Part  $AT$  of the Diameter, intercepted between  $A$  the Original of  $X$ , and  $T$  the Concourse of the Tangent and the Axe, increaseth such time as the Point  $P$  falls upon  $E$ , and after it again begins to diminish: From whence it is apparent, that  $AT$  must become the *Maximum*  $AL$ , when the Point  $P$  falls upon the Point  $E$  required.

2. In those Curves that have a Point of *Retrogression*, 'tis evident, that the Part  $AT$  increaseth continually, and that the Abscissa increaseth so long, till the Point  $T$  fall upon  $L$ , after which it again diminisheth: From whence it is clear, That  $AP$  must become a *Maximum*, when the Point  $T$  falls upon  $L$ .

Now if  $AE$  be put  $= x$ ,  $EF = y$ , then will  $AL$  be  $= \frac{y \dot{x}}{\dot{y}} - x$ ; whose Fluxion, which is

$\frac{y^2 \ddot{x} - y \dot{x} \ddot{y}}{y^2} - \dot{x}$  (supposing  $\dot{x}$  invariable) being di-

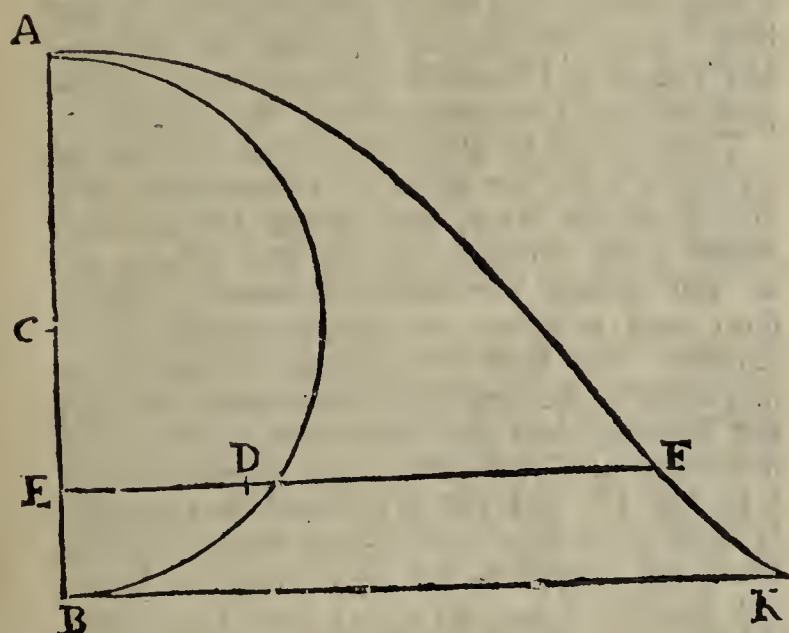
vided by  $\dot{x}$ , the Fluxion of  $AE$  must become Nothing or Infinite; that is  $-\frac{y \ddot{y}}{y^2} =$  Nothing or

Infinite: So that the multiplying by  $y^2$ , and dividing by  $-y \ddot{y}$  will be  $=$  to Nothing or Infinite, which in the Sequel will serve for a general Form to find  $F$  the Point of Inflection or Retrogression. For the Nature of the Curve  $AFK$  being given, the



the Value of  $\dot{y}$  may be found in  $\dot{x}$ ; and taking the Fluxion of this Value, and supposing  $\dot{x}$  invariable, the Value of  $\dot{y}$  will be found in  $\dot{x}^2$ , which being put equal to Nothing, or Infinity, serves in either of these Suppositions to find such a Value of  $AE$ , as that the Ordinate  $EF$  shall intersect the Curve  $AFK$  in  $F$  the Point of Inflection or Retrogression. Of this I shall only now, from the *Analyse des Infiniment Petits*, give one

## E X A M P L E.



Let  $AFK$  be a protracted Semi-cycloid, whose Base is longer than the Circumference of the generating Circle  $ADB$ , whose Center is  $C$ . 'Tis required to find  $E$  in the Diameter  $AB$ , so that the Ordinate Applicate  $EF$  shall cut the Semi-cycloid in  $F$ , the Point of contrary Flexion.

Suppose the known Quantities  $ADB = a$ ;  $BK = b$ ;  $AB = 2c$ , and the unknown Quantities  $AE = x$ ,  $ED = z$ , the Arc  $AD = u$ ,  $EF = y$ ; then by the Property of the Cycloid  $y = z + \frac{bu}{a}$ ;

and therefore  $\dot{y} = \dot{z} + \frac{b\dot{u}}{a}$ : But by the Property of the Circle  $z = \sqrt{2cx - xx}$ , and consequently  $\dot{z} = \frac{cx - xx}{\sqrt{2cx - xx}}$ , and  $\dot{u} \left( \sqrt{x^2 + z^2} \right)$

$= \frac{cx}{\sqrt{2cx - xx}}$ : Therefore substituting for  $\dot{z}$  and  $\dot{u}$  their respective Values, we have  $\dot{y}$

$= \frac{acx - ax\dot{x} + bc\dot{x}}{a\sqrt{acx - xx}}$ , and the Fluxion there-

of, (supposing  $\dot{x}$  invariable) is,

$\frac{bcx - acx - bcc \times \dot{x}}{2cx - xx \times \sqrt{2cx - xx}} = 0$ ; that is,  $AE(x) = c + \frac{ac}{b}$ , and  $CE = \frac{ac}{b}$ .

Hence it is evident, That to have  $F$ , a Point of contrary Flexion,  $b$  must be greater than  $a$ ; for if it be less, then  $CE$  would exceed  $CB$ .

**INFLEXION of the Rays of Light.** Sir Isaac Newton, in his excellent *Opticks*, Book III. makes these Experiments and Observations on this surprising Phenomenon.

1. That in a well darken'd Room, a Hole, whose Diameter was  $\frac{1}{4}$  of an Inch, being made with a Pin in a Plate of Lead, to let in the Sun's Rays; he found that the Shadows of Hairs, Threads, Pins, Straws, &c. placed in that Beam of Light, were very considerably broader than they ought to be, if

the Rays of Light had passed on by those Bodies in Right Lines: And for Instance, that the Hair of a Man's Head, whose Breadth was about the 280th part of an Inch, did, at the distance of 12 Foot from the Hole, and 4 Inches from the Hair, cast a Shadow which was a 60th part of an Inch broad, or four times its own Breadth; at 2 Foot from the Hair, the Shadow was ten times as broad as the Hair; and at the distance of 10 Foot, it was 35 times as broad. And he found, that it was not material, whether the Hair was encompassed with Air, or with any other pellucid Substance: For if the Hair were placed between polished Glasses, with Water between them, the Shadows were all one; as were also the Shadows of Scratches made on the Surface of polished Plates of Glass, and of the Veins of such Glasses: And therefore the great Breadth of these Shadows must arise from some other Cause than the Refraction of the Air. It is plain also from this Experiment, that the Rays are bent, and turned aside, in passing by the Hair, &c. and that the Hair acts on the Rays of Light at a good distance as they pass by it. And he shews, that the Action is strongest on the Rays which pass by at the least Distances, and grows weaker as the Rays are further from it.

2. He observed that the Shadows of all Bodies in this Light were border'd with three parallel Fringes of colour'd Light; whereof that next the Shadow was luminous. It was difficult to distinguish the Colours, unless the Light pass'd very obliquely on a white Paper, and then they exhibited Colours in this Order from the Shadows, viz. Violet, Indico, Pale-blue; Green, Yellow, Red; Blue, Yellow, Red; Pale-blue, Pale-yellow, Pale-red.

3. He took accurately the Measures of these Fringes, which he there gives in a Table.

And in the 4th Observation he shews, That the Breadth of the Fringes (when cast obliquely on a smooth white Body) seem'd to be in the Progression of the Numbers,  $1 \sqrt{\frac{2}{3}}$ ,  $\sqrt{\frac{2}{5}}$ ; and their Intervals in the same Proportion with them; i.e. the Fringes and their Intervals together to be in the continued Progression of  $1 \sqrt{\frac{2}{3}}$ ,  $\sqrt{\frac{2}{5}}$ ,  $\sqrt{\frac{2}{7}}$ , or thereabouts.

5. The Sun shining into a darkened Room thro' a Hole  $\frac{1}{4}$  of an Inch broad, at 2 or 3 Foot from it, he placed a Sheet of Pastboard, black'd well all over; and which had in the middle a Hole about  $\frac{3}{4}$  of an Inch square for the Light to pass through. Behind the Hole, on the Pastboard, he fastened with Pitch the Blade of a sharp Knife, to intercept some part of the Light which passed through the Hole. Both Pastboard and Knife were placed perpendicular to the Rays of Light. Then placing the Pastboard so that all the Light fell upon the Hole in it, and part of it on the Blade of the Knife there placed, while the other part went by the Edge; he let that part which passed by, fall on a white Paper, 2 or 3 Foot beyond the Knife; and there saw two Streams of faint Light shoot out both ways from the Beam of Light into the Shadows, like the Tails of Comets. Their whole Length, measured upon the Paper at the distance of 3 Foot from the Knife, was about 6 or 8 Inches; so that they subtended an Angle at the Edge of a Knife of about 12 Degrees.

6. He placed another by the former; so that their Edges were parallel and look'd towards one another; so that a Beam of Light might fall on both, and some of it pass through between them. And when the Distance between their Edges was about the 400th part of an Inch in breadth, the Stream of Light that passed through parted in the middle



middle, and left a Shadow between the two Parts: And this Shadow was so black and dark, that all the Light which passed between the Knives, seem'd to be *bent* and *turned aside* to the one hand or the other. As the Knives approach'd, the Shadow between the Streams of Light grew still broader, till at last, on their Contact, the whole Light vanished. Hence I gather (saith he) that the Light which is *left bent*, and goes to the *inner Ends* of the Streams, passes by the Edges of the Knives at the greatest distance: And *this Distance*, when the Shadow begins to appear between the Streams, is *about the 800th part of an Inch*: And the Light, which passes by the Edges at *less Distances*, is *more bent*, and goes to those Streams which are further from the direct Light.

7. The *Fringes* above mentioned also appear'd in this Experiment. And he gathers from this and the former Observation, that the Light of the first Fringe passed by the Edge of its Knife at a Distance greater than the 800th part of an Inch; and the Light of the two or three Fringes at still greater Distances; and consequently, that the Rays, which caused the *Streams* of Light, passed nearer to the Knives Edges than any other.

8. Two Knives, whose Edges were ground truly strait, were placed so (by sticking their Points into a Board, with their Edges towards one another) as to make an Angle of above  $1^{\circ} 54'$ . Here thro' a Hole, the 42d part of an Inch wide, the Beam of Light was let into the dark Room; which made the Fringe appear, at the distance of 10 or 15 Foot from the Hole, and on a Ruler held obliquely, at the distance of half an Inch from the Knives, parallel to the Edges of the Shadows, and without growing sensibly broader till they met in Angles equal to that made by the Edges of the Knives, where they met and join'd without crossing. But when the Ruler was plac'd at a much greater distance, the Fringes grew broader as they approached, and after meeting cross'd one another, and then grew yet much broader.

9. From hence he concludes, That the *Distances* at which the Fringes pass by the Knives are *not increased nor altered* by the Approach of the Knives; but that the Angles, in which the Rays are there *bent*, are much increased by that Approach: And also, that the Edge of the Knife, which is nearest any Ray, *determines which way the Ray shall be bent*, and the other Knife *increases the Flexure*. In observing,

10. He found, that when the Fringes of the Shadows of the Knives fell *perpendicularly* on a Paper at a great distance from the Knives, they were in the form of *Hyperbola's*.

11. When he placed a Prism at the Hole (made with a small Pin) to refract the Light, he found that the Shadows of all Bodies held in the colour'd Light between the Prism and the Wall were bordered with Fringes of the Colour of that Light only in which they were held: And also, that the Fringes in the *Red* Light were *largest*, and those in the *Violet* *least*. Wherefore, the Rays which made these Fringes in the *Red* Light, pass'd by the Hair at a *greater distance*, than those which made the like Fringes in the *Violet*: And consequently the Hair, in causing these Fringes, *acts alike* on the *Red* Light, or least refrangible Rays at a greater distance; and on the *Violet*, or most refrangible Rays, at a less distance; and *by those Actions* disposed the *Red* Light into larger, and the *Violet* into smaller, and the Lights of intermediate Colours into Fringes of intermediate Bignesses, *without changing the Colour* of any sort of

Light. When therefore the Hair, in the first and second Observation, being held in the common white Light of the Sun, cast a Shadow border'd with three Fringes of colour'd Light; those *Colours* ('tis plain) did not arise from any *new Modifications* impress'd on the Rays of Light by the Hair, but only from the various *Inflections* whereby the several sorts of Rays were separated from one another; which before Separation, by the Mixture of their Colours, compos'd the *White Beam* of the Sun's Light; but whenever separated, compose Lights of the several Colours which they are originally disposed to exhibit. And this mightily confirms his Doctrine and Theory of Colours, as indeed all kinds of Experiments and Considerations do. See *Colours*.

These wonderful Properties of the *Inflection* of the Rays of Light are caused by a Body acting at a distance on the Rays; and yet this Action of *Inflection* is the stronger, the less such distance is: So that perhaps the Attraction which causes it don't exert its Sphere of Activity beyond such a distance. The Rays of Light also themselves, as they differ in Refrangibility, are diversely *inflected*, and separated into those *three Fringes* of Colours mentioned by Sir Isaac Newton in his excellent *Opticks*, Lib. III. and before observed by Grimaldus to arise from any small Bodies, such as *Hairs*, *Wires*, &c. placed in the Sun's Rays, let into a well darkned Room, by a very small Hole made only by the Point of a Needle in a Plate of Metal. And these *Fimbriae*, or colour'd Fringes, seem to be made by a kind of undulatory Motion or Inflection of the Rays, as they come near the Extremities of Bodies, the three different Colours of the Fringes arising from three such different Inflections.

INFLUENCES of the Planets, or heavenly Bodies, are such Physical Powers or Forces, as they are supposed to have on Sublunary Things.

Mr. Boyle is inclined to believe (tho' he had no Opinion of Judicial Astrology in other respects) that the Planets may have some Physical Influence or Operation on Bodies belonging to our Globe, from these Considerations.

1. That it cannot be denied, that all the Affections and Dispositions of Moisture, Heat, Cold, Drought, the Course of all Winds, Showers, Thunder, &c. and whatever else helps to produce the great and universal Effects of Rarefaction and Condensation in our Atmosphere, do in a great Measure, if not entirely, depend on the Motion, Position, Situation, and Aspects of the Superior Celestial Bodies or Planets. That every Planet hath its own proper Light distinct from every other, which Light not being a bare Quality, but designed for a further use than meer Illumination, must be accompanied with some peculiar Tincture, Virtue, or Power.

2. That this Light of each particular Celestial Body, not being at all Refracted in the *Aetherial* Spaces it is transmitted through, descends entirely and unchanged into our Atmosphere.

3. That whatever is received into our Atmosphere, is also received by the Thin and Subtile Air, which is contiguous to the Atmosphere; which cannot but be capable of being moved, stirred, altered, and influenced by these differently disposed Lights which penetrate each part of it.

4. And since the Thin and Subtile Air is capable of being thus affected, moved and altered by these Planetary Virtues, it must needs variously impress, move, agitate and infect the Spirits or Subtler Parts of all Bodies within its reach; and consequently must have a considerable Influence upon the Bodies wherein such Spirits reside, and whom they actuate.

5. This



5. This is also farther confirmed, as true in Fact, by those sudden Strokes of Cramps, Convulsions, Bites, Colds, Pestilential Invasions, &c. which do not only often, as it were in an Instant, seize on our Bodies, but which do also continue for a long time, &c.

INFLUENT [*Influens*, L.] a Term us'd when any Liquor or Juice falls into another Current and Receptacle, by the Contrivance of Nature and the Laws of Circulation.

IN FORMA PAUPERIS, in Law, is when any Man that hath a just Cause of Suit, either in the Chancery, or any other of the Courts of Common Law, will come either before the Lord Keeper, Master of the Rolls, either of the Chief Justices, or Chief Baron, and make Oath that he is not worth five Pounds, his Debts paid, either of the said Judges will in his own proper Court, admit him to sue in *forma Pauperis*, and he shall have Council, Clerk, or Attorney assigned to do his Business, without paying any Fees.

INFORMATION [in Law] is the same for the King that a Declaration is for a common Person; which is not always done directly by the King or his Attorney, but sometimes by another Person, who sues as well for the King as himself, on a Breach of some Penal Law or Statute; wherein a Penalty is given to the Party who will sue for the same.

INFORMATUS NON SUM, or rather *non sum informatus*, in Law, is a formal Answer made of Course by an Attorney, that is commanded by the Court to say what he thinketh good in defence of his Client; who being not instructed to say any thing material, says, He is *not informed*, by which he is deemed to leave his Client undefended, and so Judgment passeth for the adverse Party.

INFORMED STARS, are such of the *Fixed Stars*, as are not cast into, or ranged under any Form: see *Sporades*.

IMFRASPINATUS, or *supra Scapularis inferior*, is a Muscle of the Arm, so called, because it is placed below the Spine. This arises fleshly from the inferior part of the *Basis Scapulae*, as also from its Spine, and Inferior *Costa* and *Dorsum*; from hence passing in a triangular Form, according to the Figure of the Part, lessening itself as it marches over the Juncture it becomes tendinous, and is inserted like the *Supra Spinatus* to the Head of the *Os Humeri*. This moves the Arm directly backward.

INFUNDIBULUM CEREBRI, the same that *Choana*.

INFUNDIBULUM RENUM, is the Pelvis or Basin thro' which the Urine passes to the Ureters and the Bladder.

INFUSION, is an Extraction of the Vertue of Medicines with a convenient Liquor, which if it be Purgative, it is usually taken at one Dose; and to this the Name properly agrees.

INFUSION [in Medicine] the Action of conveying a Liquor into the Body by the Veins. A new Method of purging by infusing a Cathartick or purging Medicine into the Veins; which operates something like a Clyster.

INGEMINATED Flowers [in Botany] are such Flowers as stand on, or naturally grow out of another, as called *Hose* in *Hose*.

INGENUITAS *Regni*, was formerly used to signify the Freeholders, or Commonalty of the Kingdom, which were called *Ingenui*, *Liberi*, and *Legales Homines*: But the Word was not restrained only to *Plebeians*; since in the Reign of *Hen. I.* it was given to the *Chief Barons*.

INGENUOUS, in the Civil Law Sense, is one that was born of a Woman that was made *Free* any time after his Conception, and before his Birth.

INGREDIENTS, are the several Parts or Simples that go to the making of any Compound Medicine; and in general it signifies the Constituent Parts or Principles of a mixt Body.

INGRESS, in Astronomy, signifies the Sun's entering the first Scruple of one of the four *Cardinal Signis*, especially *Aries*.

INGRESSU, is a Writ of Entry, whereby a Man seeketh Entry into Lands and Tenements: It lies in many Cases, and hath many several Forms: see *Entry*.

This Writ is also called in particular, *Præcipe quod reddat*, because those be formal Words in Writs of Entry.

The Writs, as they lie down in divers Cases, are these, set down in the *Old Nat. Brev. viz.*

INGRESSU *ad communem Legem*, is a Writ which lieth where a Tenant for Term of Life, or of another Life, Tenant by Courtesy, or Tenant in Dower, maketh a Feoffment in Fee, and dieth: He in Reversion shall have the aforesaid Writ against whomsoever that is in the Land after such Feoffment made.

INGRESSU *ad Terminum qui præterit*, a Writ which lieth where the Lands or Tenements are Let to a Man for Term of Years, and the Tenant holdeth over his Term.

INGRESSU *Causa Matrimonii prælocuti*: see *Causa Matrimonii prælocuti*.

INGRESSU *cui ante divortium*: see *Cui ante divortium*.

INGRESSU *dum fuit infra ætatem*, is a Writ which lies where one under Age sells his Lands, &c.

INGRESSU *dum non fuit compos mentis*, is a Writ which lies when a Man selleth Lands or Tenements, being out of his Wits, &c.

INGRESSU *in Casu consimili*: see *Casu consimili*.

INGRESSU *in Casu proviso*: see *Casu proviso*.

INGRESSU *in le per*, is a Writ which lies where one demandeth Lands or Tenements, lett by another after the Term is expired.

INGRESSU *sine assensu capituli*, is a Writ given by the Common Law, to the Successor of him that alienated *sine assensu capituli*, &c. and so called from those Words contained in the Writ.

INGRESSU *super disseisina in se quibus*, is a Writ which lies where a Man is disseised, and dieth, for his Heir against the Disseisor.

INGRESSU *sur cui in vita*, is a Writ that lies where one demandeth Lands or Tenements of that Tenant that had Entry by one, to whom some Ancestor of the Plaintiff did lett it for a Term now expired.

IN *Grosse*, is a Term in Law for what belongs to the *Person* of any Lord, and not to the Manor, Lands, &c. as a *Villain in Grosse*, an *Advowson in Grosse*, &c.

INGROSSATOR *magni Rotuli*: see *Clerk of the Pipe*.

INGROSSER, in Common Law, is one that buys Corn growing, or dead Victuals, to sell again.

Also a Clerk that writes Records or Instruments of Law in Skins of Parchment.

INGROSSING *of a Fine*, is making the Indentures by the *Chirographer*, and the Delivery of them to the Party unto whom the Cognizance is made.

INGUEN, is that Place from the Bending of the Thigh to the Secret Parts.

INGUINALIS [in Anatomy] an Epithet given to any Subdivisions of the *Inguen*, or that Part of the



the Body that reaches from the Head of the Thigh to the Secret Parts, commonly call'd the Groin.

**INHARMONICAL**, *Relation*, a Term in Music; see *Relation Inharmonical*.

**INHERENCE** [in *Philosophy*] a Term applied to the Juncture or Connection of an Accident with its Substance.

**INHERITANCE**, is a Perpetuity in Lands or Tenements to a Man and his Heirs: For *Littleton lib. 1. cap. 1.* says, This Word *Inheritance* is not only understood where a Man hath *Inheritance* of Lands and Tenements by Descent of Heritage, but also every Fee-simple or Fee-tail that a Man hath by his Purchase, may be said by *Inheritance*, for that his Heirs may inherit after him.

**INHIBITION**, is a Writ to *inhibit* or forbid a Judge from farther proceeding in the Cause depending before him. See *F. N. B. Fol. 39.* where *Prohibition* and *Inhibition* are put together. But *Inhibition* is most commonly a Writ issuing out of a higher Court-Christian to a lower and inferior; and *Prohibition* out of the King's Court to a Court-Christian, or to an inferior Temporal Court.

**INHOC**, the same antiently with what is now in the North called an *Intock*, and in *Oxfordshire* a *Hitchin*, or *Hitching*; being an Out-part or Corner of some common Field plow'd up and sow'd, (usually with Oats or Tares) and sometimes fenced off with a dry Foot Hedge, and within that Year in which the rest of the Field lies fallow. It seems to be derived from *in*, within, and *Hoke*, a Corner.

**INJECTION**, is the casting (by a Syringe, &c.) some liquid Medicine into Wounds or Cavities of the Body, or of the Vessels: Clysters are hence by some called *Injections*.

Several Experiments have been made about

**INJECTION** of *Liquors* into the Veins of Animals, from whence probably some good Hints may be taken: I shall therefore mention some of them.

Sir *Fraxastati*, Professor of Anatomy at *Pisa* in *Italy*, injected a little *Aqua Fortis* diluted into the Crural and Jugular Vein of a Dog, and he died presently; and had (on opening him) all his Blood found fixed, except about the Guts: some of the great Vessels were burst.

Some *Spirit of Vitriol* being injected into the Veins of another Dog, he died not so soon, but fetched his Breath thick and difficultly, and foamed like an Epileptick; but dying at last, he opened him, and found his Blood fix'd in his Veins, grumous and like Soot.

*Oil of Tartar* injected did not kill the Dog, tho' tried upon him several times; but he grew more eager for Meat than before, and getting some Bones he gnawed them most greedily.

*Oil of Sulphur* injected swelled the Dog and killed him; his Blood was found not coagulated, but more thin and florid than ordinary; which Constitution, perhaps, may be as fatal in the Blood, as its being curdled and fixed.

**INJUNCTION**, is a Writ grounded upon an Interlocutory Order in Chancery; sometimes to give Possession to the Plaintiff, for want of the Defendant's Appearance; sometimes to the King's Ordinary Court, and sometimes to the Court-Christian, to stay Proceedings in a Cause upon Suggestion made, That the Rigor of the Law, if it take place, is against Equity and Conscience in that Case.

**INIUM**, is the Beginning of the oblongated Marrow, which is the common Sensory, because the Species which are received from the external

Organs are conveyed thither by the Nerves. *Blanchard*.

**INLAGARY**, a Term in Law, signifying a Restitution of one Outlaw'd to the King's Protection, and to the Benefit and Estate of a Subject.

**INLAND**, is an old Word found in *Doomsday* and other old Books, and signified that Part of any Land or Manor which lay next to the Mansion-house, and which was used by the Lord himself; whence it was called *Terra Dominicalis*, *Demesnes*, in opposition to *Utland* or *Outland*, which was in Tenancy. These *Inlands* the Feudists call *Terras Curtas*, *ac intra Curtem*, *Court-Lands*, or such as were appropriated to the Court or House of the Lord. So

**INLANTAL**, *Inland* or *Demesne*, was opposed to *Delantal*, or *Out-land*, or *Land-Tenanted*.

**INMATES**, are such Persons as are admitted (for their Money) to live in the same House with, and which go in at the same Door, jointly with others to whom the House belongeth; and which are not able also to maintain themselves. These are inquirable in a *Court-Leet*. See *Kitchin*, Fol. 45.

**INNATE IDEAS**. Taking the Word *Idea* in the largest and most extensive Sense (see *Ideas*) for whatsoever is the Object of our Understanding when we think; whether it be *Phantasm*, *Notion*, *Species*, &c. or whatever it is that the Mind can be employ'd about in Thinking.

The excellent Mr. *Locke*, in his most useful *Essay on Human Understanding*, hath plainly proved there are not any such things as *Innate Ideas* or *Principles*: Tho' some Writers will needs have such primary Notions, as have been called *καὶ αὐτοὶ χαρακτῆρες*, to be as it were Characters stamp'd on the Mind of Man, which the Soul receives in its very first Being, and brings into the World with it.

That which hath led Men into this Mistake, seems to have been, *First*, a Notion of the mighty Advantage of such *Innate Ideas* for the due Direction and Regulation of the Human Mind; and therefore 'tis reasonable to suppose our gracious Creator should have furnished the nascent Mind with them: And, *secondly*, that there are many Truths to which we pay so early and speedy an Assent, that they seem to be *Innate*, and interwoven as it were in our very Natures, and stamp'd and impress'd originally on our Minds.

To the former 'tis easy to answer; That, if the same Advantages will accrue to the Human Mind, from having a Power given it by God, by Study and Thought easily to gain such Notions or Principles; there is then no need of supposing them *Innate*: And if this Power can and doth exert itself early and easily, and enables us to assent to the Truth of such *useful Notions and Principles*, as soon as ever the Terms expressing them are understood, 'tis much more easy and natural to suppose the Power of obtaining them *innate*, than the Propositions and Notions themselves. Our Author might have thought it enough to refute this Doctrine, by shewing (as he admirably and clearly doth) how we may attain to all the Knowledge we have, barely by the Use of our natural Faculties, and without the Help of any *innate Impressions*: For it seems as unreasonable to attribute *Truths* to be owing to the Impressions of Nature and *innate Characters*, which we find we can gain by the Exercise of our Faculties, as to suppose those *Colours* to be *innate* in our Eyes, which on opening our Eye-lids will be painted there from external Objects, by the Operation and Action of Light.



But because some prejudicate Notions have long prevail'd *per contra*, and which one can hardly oppose without Censure; he gives us the Reasons at large, that made him doubt of the Truth of that received Opinion; which are in short such as these.

That should they argue that there are certain Principles both *speculative* and *practical*, which are universally agreed on by all Mankind: This doth not prove them *innate*, were it true in Fact, if another way can be assign'd how Men may come to such an universal Agreement in the Things they consent to.

But indeed there are none such, to which all Mankind give an universal Consent. If you take the *Speculative Principles* into view, such as, *Whatsoever is, is: 'Tis impossible any thing should be and not be at the same time, &c.* Though these have a settled Reputation as *Maxims*, and deservedly, yet are they so far from having an universal Assent from Mankind, that a great Part of it doth not so much as *know* them: As all *Children* and *Idiots*, and indeed every one that is not used to *internal Reflexion*, and *abstracted Reasonings*. But *these* have Souls; and these Souls have these Impressions, it seems, stamp'd upon them; only the Stamp cannot be seen; the Impression is *there*, but 'tis *invisible*; the *Notion* is there, but they don't know it; the *Proposition* is there, but the Mind is *ignorant* of its Truth! 'Tis plain therefore, 'tis *there to no purpose*: Wherefore, he that hath a right Notion of the Wisdom of God, will conclude it is not there at all.

If it be said, *These innate Principles lie dormant and invisible there, till the Soul comes to the use of Reason*; 'tis plain they were there before to no purpose: And if it be fully made appear, that the Exercise of our Reasoning Faculty will help us to them another way, 'tis highly probable they are *never so impressed*, and *innate*, at all.

And if our reasoning Faculties, assenting to the Truth of these Principles, as soon as we understand the Words they are express'd in, be an Argument that they are *innate*, it will prove *too much*: For it will conclude *all other Propositions to be so too*; which we consent to as soon as we understand the Terms: Such as *two and two make four, &c.* *A Square is not a Circle, Redness is not Sweetness, &c.* and ten thousand such others, to whose Truth the Mind, at first proposing, assents.

Besides, no Proposition can be *innate*, unless their Terms are *innate*; or those Ideas which those Terms express. And as no one ever said that Words and Terms are *innate*, so in the whole Course of his Book Mr. Locke shews, how and after what manner both Simple, Compounded, and Abstract Ideas come into the Mind: And he shews, that the Notion of Principles being *innate*, came probably from hence; That there being abundance of plain and obvious Truths, to which the Mind pays a ready Assent as soon as the Terms, that express them are understood, it was a much easier and shorter way for Men to suppose them *innate* there, than to trouble themselves about the Way and Manner of their coming into the Mind from without, by Observation and Experience.

INNATE Principles, according to some Philosophers, are primary Notions or Characters which they will have to be stamp'd upon the Mind of Man when it first receives its Being, and which it brings into the World with it.

INNOMINATA *Tunica Oculi*, the Tunick of the Eye that wants a Name, is a certain subtile Expansion of the Tendons, from the Muscles which move the Eye to the Circumference of the *Iris* or Horney Membrane.

INNOMINATA *Offa*, are two large Bones situated on the Sides of the *Os Sacrum*, and in a *Fœtus* may each be separated into three Bones, *Ilium*, *Os Pubis*, and *Ischium*, joined by Cartilages, and appear distinct by three Lines 'till seven Years old, but grow all into one Bone at riper Years: they are by some called *Cuneiformia*.

INNOMINATUS *Humor*, or *Infitus*, is a Secondary Humour, as the Ancients call it, wherewith they thought the Body was nourished: For those nutritious Humours they talked of are four, *Innomi-natus*, *Ros*, *Gluten*, *Cambium*. *Blanchard*.

INNOTESCIMUS, in Law, are Letters Patents, which are always of a Charter of Feoffment, or some other Instrument not of Record, and so styled in the Words of the Conclusion, *Innotescimus per præsentis*.

INNS-OF-COURT, are so called, because the Students there study the Laws, to enable them to practise in the *Courts of Westminster*, or elsewhere. These are the *Middle* and *Inner Temple*, *Lincolns-Inn*, and *Grays-Inn*. There are also two Serjeants-Inns, and eight Inns of Chancery.

INNUENDO, is a Word frequently used in Writs, Declarations and Pleadings; and its Use is only to declare and ascertain the Person or Thing which was named or left doubtful before.

INOCULATION, is a kind of Grafting by the Insertion of the Bud of one kind of Fruit-Tree into the Bark of another, so as to make different Kinds of Fruit grow on the same Tree, and the same common Sap supply them all.

INORDINATE *Proportion* [in *Mathematicks*], is supposing 3 Magnitudes in one Rank, and 3 other proportional to them in another, and you compare them in a different Order; as suppose these 3 Numbers in one Rank, 2. 3. 9. and these other 3 in another Rank, 8. 24. 36. proportional to the preceding Numbers in a different Order; so that 2 shall be to 3, as 24 to 36; and 3 to 9, as 8 to 24. Then if you cast away the mean Terms in each Rank, you conclude the first 2 in the first Rank, is to the last 9, as 8 the first of the other Rank to 36.

INOSCULATION: see *Anastomosis*.

INQUIRENDO, is an Authority given to a Person or Persons, to enquire into something for the King's Advantage.

INQUISITION, in Law, is a manner of proceeding in Matters Criminal, by the Office of the Judge, by the great *Inquest* before Justices in *Eyre*.

INQUISITORS, are Sheriffs, Coroners, *super visum corporis*, or the like, who have Power to enquire into certain Cases.

INROLMENT, in Law, is the Registering, Recording, or Entering of any lawful Act in the Rolls of the Chancery, as a Recognisance acknowledged, or a Statute, or a Fine levied; or in the Rolls of the Exchequer, King's-Bench, or Common Pleas; or in the Hustings of *London*, or by the Clerk of the Peace in any County.

INSANIA, or *Amentia*, Madness, is an Abolition or Depravation of Imagination and Judgment.

INSCONCED, a Term in the Art Military, implying that a Part of an Army hath fortified themselves with a Sconce or small Fort, in order to defend some Pass, &c. See *Sconces*.

INSCRIBED, in Geometry; a Figure is said to be *inscribed* in another, when all the Angles of the Figure *inscribed* touch either the Angles, Sides, or Planes of the other Figure.

INSCRIBED *Bodies*: see *Regular Bodies*.

INSCRIBED *Bodies*: On *Gunter's Sector*, are sometimes placed two Lines answering one another, and called the *Lines of Inscribed Bodies*, and



are easily known there by the Letters D, S, I, C, O, T, which signify the *Dodecahedron*, *Sphere*, *Icosahedron*, *Cube*, *Octahedron*, and *Tetrahedron*.

The Uses of these Lines may be these.

1. The Radius of a Sphere being given, to find the Sides of the Five Regular Bodies inscribed in it.
2. The Side of any of the Five Regular Bodies given, to find the Radius of the Circumscribing Sphere.

If the Sphere be first given, apply its Radius over in the Points S, S, on each Leg of the Sector.

If any of the other Bodies be first given, apply its Side over between its proper Letters; so the Parallel taken between the Points of the other Bodies, shall be the Sides of those Bodies, and may be inscribed in the Sphere, whose Radius is the Distance between S and S.

INSCRIBED *Hyperbola*, is such an one as lies entirely within the Angle of its Asymptotes; as the Conical *Hyperbola* doth.

INSECTIVOROUS *Animals*, are such as feed on Insects: See *Birds*.

INSECTS, a kind of living Creatures so called by *Aristotle* and *Pliny*; because of their having certain *Incisuræ*, Cuttings or Indentings, in and about their Bodies. The *Greeks* call them *Ἔντομα*. The judicious Mr. Ray, in his *Methodus Insectorum*, thus distinguishes the several Kinds of *Insects*.

*Insects* are (1.) either *Ἀμεταμορφώσιμα*, or such as do not change their Form; Or, (2.) *Μεταμορφώσιμα*, such as do really change their Form.

Those that do not change their Form, are either (1.) *Ἀποδα* without Feet, or (2.) *Πέδατα* with Feet; and of these there are some Kinds that cast their Skins.

*Insects* without Feet are either *Terrestrial*, or *Land Insects*, or *Aquatick*.

*Terrestrial Insects* are either such as are produced on the Land, or in the Earth; and not in the Water; as the *Lumbrici Terrestres*; which are either of the larger sort, and are called *Dew-Worms*; or of a smaller Size: And of these there are Red and Green, with Yellow Tails: Which last are commonly called *Gilt-Tails*.

Or such as are found in the Bowels of *Animals*: And of these some are found in the Intestines of Men; as (1.) the *Lumbrici Teretes*; (2.) *Lumbrici Latii*, which are called also *Tæniæ*. (3.) *Cucurbitini*, which some will have to be only the Fragments of the *Tæniæ*: (See *Nich. Andri, M. D. De Variis Vermium Speciebus*.) (4.) The *Ascarides*, which are chiefly found in the Rectum.

Those Worms that are found in the Intestines of Beasts are of two Sorts, the *Oblongi* and *Pellucidi*, of the Thickness of a Horse-Hair; and therefore called *Vermiculi Setiformes*: And the *Breves* and *Crassiores*, which often are found in Horses, and are called the *Botts*.

To this Genus of *Terrestrial Insects* many Natural Historians refer *Snails*, whether with or without Shells.

*Water Insects* without Feet, not changing Form, are either of the

Greater Sort, which have a peculiar way of moving, by first fixing their Head to the Ground, and then drawing up their Tail towards it, &c. Of these some are *Teretes*, round and smooth; of which are three sorts; as the *Medicinal Hirudines*, or *Leaches*; the common *Black-Horse-Leaches*, and the *Asb-colour'd Sea-Leaches*: But there is also a sort of this kind that is smaller and flatter, which is found sticking to Stones in the Bottoms of little Brooks.

Lesser Sort, which have a different way of crawling or moving from the former. These also are either round or flat: Of the round sort there is one

that is *Black*, with two small Horns on its Head; and is found sticking to wet Stones in the watery Tops of Hills: And another, which is *Red*, of about a Finger's length, with a Forceps at the Tail, found at the bottom of Fish-Ponds and stagnant Waters.

The Flat Sort are very small and thin, and are called *Flukes*; being sometimes found in Waters, and sometimes in the Branches of the *Porus Bilarius* in Sheep.

*Insects not changing Form, and having Feet*, are either (1.) *Hexapoda*, with six Feet; (2.) *Octapoda*, with eight Feet; (3.) with fourteen Feet; (4.) *Poly-poda*, with many Feet.

Those that have but six Feet, are either,

1. *Terrestrial*; and these of a larger kind; as (1.) The Yellowish *Insect* found in rotten decaying Oaks; (2.) The Black one on the Ground, called by *Mouffet*, *Vermivorous*; (3.) The Black one living under Ground, with a Forceps at the Tail; (4.) A White Sort, with square Black Spots on its Back; (5.) The *Farinarium*, bred in Meal, of a whitish Colour.

Smaller Sort: Some of which are found about the Bodies of *Animals*; as (1.) the *Cimex*, or *Wall-Louse*, of a stinking Smell; (2.) *Ricinus*, the Tick; (3.) *Pediculus*, the common Louse; (4.) *Pediculus fesus* seu *Inguinalis*, the Crab-Louse; (5.) *Pulex* the Flea; of all which there are various kinds.

Others are not troublesome to *Animals*; as (1.) One that in Bigness and Figure resembles a Louse, but is very nimble and swift, and is found in Books and rotten Wood; (2.) Another there is with a very long Body, and a forcipitated Tail; (3.) The *Black Insect*, found often in the Flowers of the *Che-lidonium*; (4.) A subterraneous Sort, a little whitish; (5.) One that skips like a Grasshopper, but is much less.

2. *Aquatick*: As (1.) the *Pediculus Marinus Grandis*, which adheres to Fishes; (2.) The *Squilla Fluvialis*, with a Pyramidal Tail, and two Hairs or Bristles at the End.

*Insects not changing Form, and having eight Feet*, are either with a Tail, as the *Scorpion*; or without, as the *Spider*; of which some spin no Web, have but two Eyes, and very long Legs, as the *Opilio*, or the *Shepherd*.

Some do spin a Web; and of these they count three sorts: (1.) The *Aranea Colcestrensis Abdomine tumido, subrotundo & elato*; (2.) The *Spider* with the Thorax, or middle Part of its Body, as big as the Abdomen; (3.) The *Spider* with the long Abdomen, found among Reeds, Rushes, Grass, &c.

2. The *Ricini Octopodes*, which are some more flat and compress'd; as the rambling Ticks that run o'er the Bodies of *Animals*, but don't fasten; and some more round and thick, which do adhere to the Skin.

3. The *Syrones* or Mites.

*Insects not changing Form, and with fourteen Feet*, and therefore by Mr. Ray called *Τεσσαρακισδενάποδα*, are the *Aselli*: Of which there are three Sorts: As,

1. The *Sea-Asellus*; the longest and largest of all; living amongst the Rocks.

2. *Asellus Lividus*; which rolls itself up into a Ball. The Common Wood-Lice, Sows or Chess Buggs.

3. *Asellus Asininus*, with a forked Tail, not rolling itself up. To this Species may be added the *Asellus Marinus Figuræ brevioris*, rolling itself up; (2.) *Asellus Aquarum dulcium*, with long Legs, and two Bristles on its Tail; (3.) *Pulex Aquaticus*, both in fresh and salt Water; (4.) *Pediculus Aquaticus*, which fastens upon Fish.



*Insects not changing Form, with twenty-four Feet.* These have the eight Fore-feet lesser, and the sixteen Hinder ones larger. There are two kinds of them observ'd, both with long Bodies, one larger, and of an obscure Colour, among the Rocks by the Sea-sides; the other of a Silver Colour, found in Houses.

There is a Kind with thirty Feet, of an oblong Shape, Chesnut Colour, and full flattish Body, usually lying under Logs and Trunks of Trees. 'Tis very agile and swift.

*Insects not changing Form, with many Feet* (called *πλύπδα*) are some on Land; and either roundish in Body, with all their Legs rising out of the middle of the Belly (nearly), as the *Julus*; or more flat and compress'd, with their Legs not rising as before from a Point in the middle of their Body, but growing along on the Sides; as the *Scolopendra*. And some of this kind are

*Aquatick*; of which Mr. Ray makes three Differences: (1.) The *Cornish Luggs*, used for Baits in catching Fish, with 38 Legs, and a smooth roundish Body; (2.) The *Scolopendra Marina*, *Corpore plano*; (3.) *Animalculum Bicorpor*, or rather *Bicaudatum*, lying in the Clefts of Stones, under the Salt-Water.

*Insects which do really undergo a Change of their Form*, are called *Μεταμορφόμενα*; of which *Swammerdam* hath given the best Account: Tho' he shews that this Word is improperly used, since there is by no means any real Transformation, but only an Explication of the Parts of the Animal, latent before in Miniature (as it were in the *Ovum* or *Nympha*, like the Plant in the Seed) and an Increase of all the Parts by proper Degrees.

The first Species of Transmutation or Change (which *Swammerdam* makes the second) is instantaneous; there being no sensible Rest or Stop between the old and the New Form. And the Insects of this Order don't lose their Motion at the time that they shift the *Pellicula*, at least not to Appearance. And *Swammerdam* describes the second Order of Change to be, when the *Vermiculus* (leaving the former Shape of the *Nympha*, with which it appeared in the Egg, and subsisted without Food) now beginning to feed, hath its Members or Parts visibly increased and stretched out, and takes the Form of a new *Nympha*, which is not without Motion, and from thence becomes a Flying Insect. Of this sort are,

1. The *Libellæ*, or *Perlæ*, which are produced from an Insect of six Feet. *Vid. Mouffet*, p. 322. who takes it for the *Pulex Marinus*, as in the preceding Page he calls it the *Locusta Aquatica*. Out of the crustaceous Skin or Husk of this Insect, the *Libella* breaks by a Fissure, which begins between the Eyes, and is continued to the Roots of the Wings, and is there join'd to the Lateral Fissures.

2. The *Cimices Silvestres*, whose Characteristick Marks, according to *Willoughby*, are, (1.) A long *Proboscis*, not spiral, but strait; (2.) Their upper Wings to the middle are thick and like Leather, thence to the Ends thin and membranous; (3.) There is the Figure of St. Andrew's Cross on their Backs.

3. The *Locustæ*; which *Willoughby* refers to the Insecta *Ἀμεταμορφώτα*.

4. The *Grylli Campestris*.

5. The *Grylli Domestici*, or *Crickets*.

6. The *Gryllo-Talpa*, *Mole-Cricket*.

7. The *Cicada*, or *Grasshopper*.

8. The *Blatta*, according to *Swammerdam*.

9. The *Tipulæ Aquaticæ*, which run very swiftly on the Surface of the Water, and have a Sting in their Mouths like the *Cimices* or *Ticks*.

10. The *Scorpius Aquaticus*, with a Sting also in its Mouth.

11. The *Muscæ Aquaticæ*; called by *Androvandus*, *Apes Amphibia*.

12. The *Heimerobius*, or *Ephemera*, or *Diaria*, of *Swammerdam*.

13. The *Forficula*, or *Auricularia*. *Vid. Mouffet*, p. 175.

The Second Species of Transmutation includes such Insects as undergo a double Metamorphosis, or Change of Shape.

1. Into a *Chrysalis*, or something analogous to it.

2. Into a Flying Insect.

These Kinds of Insects, a while before their Change, lie quite still, without Food or changing Place; and in respect of their Wings are

1. *Κλείσθητες*, or *Vaginipennia*, as the *Scarabæi*, *Beetles*.

2. *Ἀνέλυτες*, whose Wings are open and expanded: And the Wings of these are either *Farinaceous*, as the *Papiliones*, &c. or *Membranous*, as the *Apes*, *Muscæ*, &c. and these are either *Δίπτερες*, with two Wings, or *Τετραπτερες*, with four Wings.

The *Scarabæi* may be divided (1.) In respect of their Horns, into the *Nasicornis*, *Bucerota*, and *Cervus Volans*, or *Taurus*. (2.) In respect of their *Antennæ*, they are of many kinds; of which the most eminent are those called *Capricorni*. (3.) With regard to their Motion, as the *Saltatrices*. (4.) With regard to their Colour, as *Cantharides*.

To the Beetle Kind may be referred the

*Cicindela*, or *Glow-Worm*: The

*Staphylinus*, called by *Willoughby* *ἡμικλείσθητες*: The

*Proscarabæus*, or *Oil-Beetle*; so called from its emitting from its Joints a kind of Oil, on its being pressed or squeezed.

The *Anelytra*, with farinaceous or mealy Wings, are called *Papiliones*, *Butterflies*; and these are either *Diurnal*, or *Nocturnal*, or the *Phalæna*.

The specifick Distinction of the *Diurnal* is, that they always settle with their Wings erect, are produced from an angulous *Aurelia*, and have their *Antennæ Studded* (*Clavata*). Of these there are about 50 Kinds observed in *England*.

The *Nocturnal Butterflies*, or the *Phalæna*, are vastly numerous; and cannot very clearly be methodized. But for Memory and Distinction's sake they may be divided into,

1. The *Geometrigenæ*, which come from the *Eruca*, (called *Geometra*, from the manner of its Walk, which is *Ansatini*, by curling up its Back like the Handle of a Cup, &c.) with 8 or 10 Feet.

2. Such as come from *Erucæ*, with 14 Feet. Of this Kind, which is very numerous, there hath been distinguished the *Phalæna Fasciata*, whose Wings are in Patches or Area's of different Colours: *Phalæna Lineata*, whose Wings are marked with transverse Lines: *Phalæna Punctata*, whose Wings are mark'd with one or more Points. And these excepted, all the others are distinguished into greater and lesser, and of a middle Size between both. One of the larger Kinds may be distinguished also by their inner Wings running out beyond the upper, when they sit or rest: And another by the Appearance of the Figure of Eyes upon the Wings: And a third by their long Tails and narrow sharp Wings; which by some are called *Phalæna Prædatrices*, or *Accipitrinæ*.

The *Anelytra*, with membranous Wings, are *Bees*, *Flies*, *Wasps*, *Bombylii*, *Crabrones*, &c. And to this Kind the *Culex Vulgaris* (*vid. Swammerdam*, p. 95. *Hist. Insects*) or *Gnat* is referr'd; as also the *Formica*, or *Ant*.

And



And hither must be referr'd such *Water Insects* as are cover'd by a *Theca*; according to the Observations of *Willoughby*. And these have either

1. An *immoveable Theca*, or Case, which is fixed to the Stones; and this Case is either of a round Figure, or of one more compressed and flat.

2. A *moveable portable Theca*; and these are commonly called *Phryganea*.

And this *Theca* is either,

1. *Strait*; and that either composed of Straws and little *Festucæ*, lying parallel one to another; of which there are two Kinds; a greater, where the *Festucæ* are two Inches long; and a lesser, which is very common, and are called *Straw-Worms*: Or else the *Festucæ* lie transversly, and are shorter, having sometimes Pieces of Shells and Stones intermix'd with them. Others, whose Cases are *strait* also, have no *Festucæ*; but always either Sand or Gravel. And of these, some have the *Theca* round, and are called *Cod-Baits*: Others are *flat* and *compressed*.

2. *Crooked* or *Horned*; which run tapering. Of these Mr. *Ray* reckons four Kinds; a greater and lesser Black Sort, and a greater and lesser Ash-colour'd one.

These all produce Flies with large Wings, like Butter-flies.

The *Third Species of Transmutation* is a simple Change from a *Vermiculus* to a flying *Insect*; but yet with a sensible *æstiva*, Rest or Stop, between one Form and the other.

This Change *Swammerdam* thus describes:

"The *Vermicle*, excluded from the Egg, gets "Nourishment, by little and little, from without; "and under that *first Skin* or Covering hath its "Members increased by degrees; not slipping it, "or putting it off, as other *Vermiculi* do when they "change into *Nymphæ*, but assuming the Figure of "a *Nympha* in it: For a time 'tis quite motionless, "till the superfluous Moisture is evaporated, and "then in a few Days recovers its Motion again; and "then casting off this Skin, which is as it were "double, it becomes a Flie."

Of this Kind are our *Flesh-flies*, and all the *Nymphæ Vermiformes*, the *Vespæ Ichneumones*, &c.

As to the *Generation of Insects*, Dr. *George Gordon*, in *Philos. Transact.* N. 237. from the Observations he had made about the true Origin of Caterpillars, concludes very well; (1.) That we ought not to believe that any *Insects* are bred of Corruption, and not *ex Ovo*, only because we cannot discern the particular Manner of their Propagation; because there are and may be more full Discoveries made of that kind accidentally, where the Process is not visible to the naked Eye. (2.) The Female *Insects* of all Kinds of Flies and Butter-flies do put their Spawn near those Places where the *Eruca's*, which are hatched out of them, are to have their Food. (3.) There is a kind of Gluten, by which the Female fastens her Eggs to the bearing Buds of Trees, &c. so that the Rains cannot wash them off. (4.) These Eggs will not be hurt by the greatest Frost.

Mr. *Andry*, in his Book *De la Generation de Vers dans le Corps de l'Homme*, Paris, 8vo. 1700. takes notice, that the Ancients were mistaken in denying that *Insects* did breathe, on the account of their wanting Lungs: For modern Observations do convince us, that *Insects* have a greater Number of Lungs than other Animals. The Ancients thought also that *Insects* had no Blood, because many of them had no red Liquor like our Blood: But 'tis

not the Colour, but the Use of the Liquor that is to be regarded. They believed also that *Insects* had no Hearts; whereas our Microscopes do now discover, that when *Insects* have several Lungs, they have also several Hearts; and in particular 'tis found that Silk-worms have a continued Chain of Hearts, from the Head almost to the very Extremity of the Tail. And 'tis this Number of Hearts and Lungs that occasions those *Insects* to give Signs of Life a long while after they are divided into several Parts. He observes also that 'tis wrong to call *Insects imperfect Animals*, since they want no Parts either necessary or convenient for their Use, and to render them compleat in their Kind.

Mr. *Poupart* affirms that the Earth-Worms and round-tail'd Worms, which are found in the Intestines of Men and Horses, &c. also Snails and Horse-Leaches, are *Hermaphrodites*; but that such Worms as become Flies, and Silk-Worms, are not so, being of *no Sex*, but are Nests full of real Animals, which we see in time come out with Wings. *Histoire de l'Academ. Royale des Sciences, Année 1699.*

#### Writers about Insects.

*Historia generalis Insectorum, Pars prima.* By *J. Swammerdam.* *Ultraject.* 1669. 4to.

*Joh. Goedartius de Insectis, cum Appendice.* By *Dr. Lister.* 1682. 4to.

*Malpighius de Bombyce.*

*Esperienze intorno alla Generatione de gl' Insetti.* By *Fr. Redi.* 1668. 4to.

*Moufeti Theatr. Insectorum.* Lond. 1634. cum Fig.

*Mart. Lister Historiæ Animalium Angliæ Tres Tractatus: Unus de Araneis; alter de Cochleis, tum Terrestribus tum Fluvialibus; tertius de Cochleis Marinis.* Lond. 1678. *Ejusdem Exercitatio Anatomica de Cochleis & Limacibus.* Lond. 1694. 8vo.

INSERTION [in *Anatomy*] a Term us'd to signify the Implication of one Part within another, as of the Bones, Muscles, and Nerves in the Members of an animal Body.

INSESSUS, is a Bath for the Belly, proper for the lower Parts, wherein the Patient sits down to the Navel. They are for several Uses; as for easing of Pain, softning of Parts, dispelling of flatulent Matter, and frequently for exciting the Courses. *Blanchard.*

INSIMUL *Tenuit*, is one of the Species of the Writ called *Formedon*; which see.

INSINUATION of a *Will*, in the Civil Law, signifies the first Production of it, or the leaving it *penes Registrum*, in order to his Probate.

INSISTING; the Angles in any Segment, in Geometry, are said to be *insisting* upon the Arch of the other Segment below.

INSITIO, the Botanick Word for *Grafting*; it signifies in general, the Insertion and uniting of any Cyon, Bud, &c. into the Substance of the Stock, and is of divers Kinds.

INSOLATION, is exposing of any Body to be warmed or heated by the Beams of the Sun.

INSPEXIMUS, are Letters Patent, so called because they begin, after the King's Title, with this Word *Inspeimus*; and is the same with *Exemplification*.

INSPIRATIO, is an alternate Dilatation of the Chest, whereby the nitrous Air is communicated to the Blood, to accend it by the Wind-pipe and its *Vesicular Parts*.



The Cause of *Inspiration* doth not seem to consist only in the Dilatation of the Thorax, as is commonly thought, but also in the Contraction of the Tunick, which covers the upper part of the *Oesophagus*, and the most close Recesses of the *Aspera Arteria*. *Blanchard*.

INSTALLMENT, is a Settlement or sure placing of any Person in his proper Place: See 20 *Car. 2. c. 2*. 'Tis sometimes confounded in the Law with Abatement. The Word is chiefly used for the Induction of a Dean, Prebendary, or other Ecclesiastical Dignitary, into the Possession of his *Stall*, or proper Seat, in the Cathedral Church to which he belongs. 'Tis sometimes called *Installation*.

INSTAURUM, is used in old Deeds for a Stock of Cattle; and was commonly taken for the whole Stock upon a Farm; as Cattle, Waggon, Ploughs, and all other Implements of Husbandry. So *Instaurum Ecclesiae* was used for the Books, Vestments, and Utensils belonging to a Church. And *Instaurata Terra*, was Land ready stock'd with all Things necessary for the Use of the Farmer. *Instauratio* is often used in this Sense by our old Historians and MSS.

INSTANT, is such a Part of Duration wherein we perceive no Succession; or is that which takes up the Time of only one *Idea* in our Minds, without the Succession of another, wherein we perceive no Succession at all.

INSTINCT [*Instinctus*, L.] A Disposition or natural Sagacity with which Animals are endued, by vertue of which they are enabled to provide for themselves, know what is good for them; and is determined to preserve and propagate the Species. This supplies the want of Reason in Brutes, and bears some Analogy to it.

INSTITUTION, is the Act of the Bishop, or one commissioned to act for him; whereby any Clerk is invested with the Spiritualities of a Rectory or Vicarage.

The Clerk kneels down before the Bishop while he pronounces the Words of *Institution*, (*Instituto te Rectorem Ecclesiae de A. B. cum Cura Animarum, & accipe Curam tuam & meam*) and the Clerk holds the written Instrument, with the Episcopal Seal annexed, in his Hand during the Ceremony. But the Clerk must have *Induction* after this, without which he hath no Right to his *Temporalities*, if the Benefice be not a Donative.

Before the Clerk is instituted, he must subscribe the 39 *Articles of Religion*, in the Presence of the Ordinary (or his Substitute;) And the Ordinary is not bound to offer them, but the Clerk is to offer to subscribe them; and he must subscribe them without Reserve, Exception or Qualification, or else his *Institution* is *ipso facto* void and null; and the Church is still vacant.

At the same time the Ordinary requires the Clerk to subscribe the other two *Articles* mentioned in *Can. 26*, about the King's Supremacy, and the Lawfulness and Use of the Liturgy.

The Clerk must also, before *Institution*, subscribe to that Part of the Declaration enjoined by the Act of Uniformity, 14 *Car. 2. c. 4*. *Viz. I will conform to the Liturgy of England as by Law establish'd*.

Before *Institution* he must also take the Oaths mentioned in the first *Statute of William and Mary*, c. 8. instead of the former Oaths of *Allegiance* and *Supremacy*, required by *Stat. 1 Eliz. c. 1*.

And then he must take the Oath against Simony, enjoined by *Can. 40*, and the Oath of Canonical Obedience. All this before *Institution*.

And he is to have Certificates given him of his subscribing the Declaration, contained in the Act of Uniformity, in *English*, in a distinct Instrument, under the Hand and Seal of the Bishop; and of his other Subscriptions and Oaths in *Latin*.

The Clerk ought to have, by all means, Witnesses of his *Institution*, his taking the Oaths, making Subscriptions, &c. and therefore he should desire some present to write their Names on the Back of his Instruments; and make *Memorandums* who they are, and where they live.

The Church, by *Institution*, is full, against all Persons but the King; and the Clerk by it may enter upon the Glebe, and take the Tithes; but he cannot *Lett* or *Grant* them, nor *Sue* for them, if they are refused to be paid.

After *Institution* the Clerk is to receive a written Mandate from the Ordinary to the Archdeacon, or other proper Person, in order to his *Induction*; which see.

INSTITUTIONS, or *Institutes*, Part of the First of the Four Tomes or Volumes of the Civil Law, and is a Compendium of the Digest drawn into Four Books, composed on purpose by the Emperor for the Use of young Students, that so having the first Elements of the whole Profession in this little Treatise, they might the sooner gain a competent Knowledge of it, without being discouraged by the Largeness of the former Books.

INSTRUMENTS, *Mathematical* and *Mechanical*, are described under their proper Names.

INSULATA *Columna*, in Architecture, is a Pillar which stands alone, like an Island, as it were, in the vast Ocean of the Air. *Evelyn's Parallel*.

INSULT, is a Word used in the Military Art, for attacking any Post with open Force, without using Trenches, Saps, or any common Approaches. 'Tis usual to *Insult* thus the *Counterscarp* of any Place, that they may not give the Enemy time to fire their Mines, which they have prepared.

INSUPER, is a Word used by the Auditors of the *Exchequer*: In their Accounts they say, So much remains *Insuper* to such an Accountant: That is, so much remains due on such an Account.

INTACTÆ, are Right Lines, to which Curves do continually approach, and yet can never meet with them: These are usually called *Asymptotes*; which see.

INTAGLIO'S, are precious Stones engraved with Heads of Great Men, or Inscriptions, &c. such as are often set in Rings, or Seals.

INTEGERS, from the Latin *Integrum*, signifies in Arithmetick whole Numbers, in Contradiction to Fractions.

INTEGUMENT [*Integumentum*, L.] a Term apply'd by Anatomists to the Skins or Membranes which cover the Parts within the Body, as the Coats or Tunicks of the Eye.

INTEGRAL *Calculus* [in the new *Analysis*] is that which answers to the differential *Calculus*.

INTELLECT [*Intellectus*, L.] a Term which the Philosophers use for that Faculty of the Soul usually called the Understanding.

INTENDMENT of Law; signifies the true Meaning and Intention of the Law.

INTENSION, is a Writ that lies against him that enters after the Death of a Tenant in Dower, or other Tenant for Life, and holds him out in the Reversion or Remainder: And every Entry upon the Possession of the King is called an *Intension*;



as where the Heir of the King's Tenant enters after Office, and before Livery, this is called an *Intension upon the King*.

*Intension*, in Natural Philosophy, signifies the Increase of the Power or Energy of any Quality, such as *Heat, Cold, &c.* for of all Qualities they say, they are *Intended* and *Remitted*; that is, capable of Increase and Diminution. Under the Word *Quality* you will find it demonstrated, that the *Intension* of all Qualities increases reciprocally, as the Squares of the Distances from the Center of the radiating Quality decreases.

To **INTENT** [in the *Civil Law*] is to begin or commence an Action or Process.

**INTENTION**, or *Study*, is when the Mind with great Earnestness, and of Choice, fixes its View on any *Idea*, considers it on all Sides, and will not be called off by the ordinary Solicitation of other *Ideas*.

**INTER** *Canem & Lupum*, was an Expression formerly used for *Twilight*. In the North this is called in some Places *Day-light's Gate*; and in others, *betwixt Hawk and Buzzard*. In *Herefordshire* 'tis called corruptly the *Muck-Shade*, i.e. *Mock-Shade*.

**INTERCALARY-DAY**, is the odd Day put in or inserted in the *Leap-Year*.

**INTERCEPTED-AXE**, a Term in Conick Sections, signifying the same with *Abscissa*; which see.

**INTERCOLUMNIATION**, is the Space or Distance between the Pillars of any Building.

**INTERCOLUMNIATION** [in *Architecture*]. The Intercolumns must always be proportioned to the Height and Bulk of the Columns. In the *Dorick* Order this is regulated according to the Distribution of Ornaments in the Freeze; but in the other Orders, according to *Vitruvius*, is of 5 Kinds, viz. *Pychnostyle, Systyle, Eustyle, Diastyle, and Aræostyle*. But some Authors have laid down the following Proportions for the *Intercolumns*, as a Medium. In the *Tuscan* Column, the *Intercolumn* must be 4 Diameters of the Column below: In the *Dorick* 3: In the *Ionick* 2: In the *Corinthian*  $2\frac{1}{4}$ : And in the *Composit*  $1\frac{1}{2}$ .

**INTERCOLUMNS**, or *Intercolumniation*, in *Architecture*, are the Spaces between Column and Column in any Portico or great Piazza, &c.

**INTERCOMMONING** [in *Law*] is when the Commons of two Manors lie together, and the Inhabitants of them both have caused their Cattle to feed promiscuously in each, time out of Mind.

**INTERCOSTAL-ARTERIES**, are Arteries, according to some, so called, because they go to the Regions about the Ribs: The upper bestows itself among the Muscles that are between the four highest Ribs; and the under one goes to every Muscle that is between the rest of the Ribs.

**INTERCOSTAL-VESSELS**, are the Veins and Arteries that run along the Intervals or Spaces of the lower and upper Ribs; on which account they are distinguished into Superior and Inferior.

**INTERCOSTALES Externi & Interni**, are Muscles placed in the Intervals of the Ribs, as their Names declare. Their Number on each Side is twice eleven, equal to the Interstices in which they are lodged. Their Originations are differently assigned by Anatomists; but 'tis most probable that they do arise from the lower Edge of each superior Rib, and are inserted to the upper Edge of each inferior one. These are thin and fleshy. The Fibres of the External pass from above obliquely down-

wards to the Fore-part, or *Offa Pubis*; those of the Internal descend in like manner obliquely towards the Back-part, or *Os Sacrum*, their Fibres decussating each other like the Letter X.

**INTERCUS**; see *Anasarca*.

**INTERDICT**, was a Censure formerly inflicted by Bishops or Ordinaries in Times of Popery; forbidding all Sacraments and Divine Offices (except Baptism to Children, and the Sacrament of the Eucharist, and Extream Unction at the Point of Death) to be performed within any Parish, Town, Country, or Nation; and sometimes they prohibited them within such Places to be present at Divine Service in any other Place. This Censure was commonly inflicted on a Pretence that the Privileges of the Church had been violated by the Lords, Magistrates, or Princes of any Place or Nation. In the Reign of our King *John*, this Kingdom lay under a Papal *Interdict* for above six Years together: It began *A. D.* 1208. In our Common Law the Word

**INTERDICTION** is used also in the same Sense as in the Canon Law; where 'tis defin'd to be *Censura Ecclesiastica prohibens administrationem divinarum*: And thus 'tis used 24 *Hen.* 8. c. 12.

**INTEREST**, is the Sum reckon'd for the Loan or Forbearance of some principal Sum lent for (or due at) a certain time, according to some certain Rate, and therefore called *Principal*, because it is the Sum that procreates the *Interest*, or from which the *Interest* is reckon'd; and is either *Simple* or *Compound*.

I. *Simple Interest* is counted from the *Principal*, and is computed as follows:

Let  $\left\{ \begin{array}{l} P = \text{Any Principal or Sum put to Interest.} \\ R = \text{The Ratio of the Rate, per Cent. per Ann.} \\ t = \text{The Time of the Principals Continuance at Interest.} \\ A = \text{The Amount of the Principal, and its Interest.} \end{array} \right.$

*Note*, The Ratio of the Rate, is only the Simple Interest of 1*l.* for one Year, at any given Rate; and is thus found:

Viz.  $100 : 6 :: 1 : 0.06 = \text{the Ratio, at 6 per Cent. per Ann.}$

Or,  $100 : 7 :: 1 : 0.07 = \text{the Ratio, at 7 per Cent. &c.}$

Again;  $100 : 7.5 :: 1 : 0.075 = \text{the Ratio, at 7 and } \frac{1}{2} \text{ per Cent.}$

And if the given Time be whole Years, then  $t = \text{the Number of whole Years}$ ; but if the Time given, be either pure Parts of a Year, or Parts of a Year mixed with Years, those Parts must be turned into Decimals; and then  $t = \text{those Decimals, &c.}$  Now the common Parts of a Year may be easily turned or converted into Decimal Parts, if it be considered

That one  $\left\{ \begin{array}{l} \text{Day is the } \frac{1}{365} \text{ Part of a Year} = 0.00274 \text{ fere.} \\ \text{Month is the } \frac{1}{12} \text{ Part of a Year} = 0.0833333, \text{ &c.} \\ \text{Quarter is the } \frac{1}{4} \text{ Part of a Year} = 0.25 \end{array} \right.$

These Things being premised, we may proceed to raising the Theorems.

Let  $R = \text{the Interest of 1 l. for one Year, as before.}$

Then  $2 R = \text{the Interest of 1 l. for two Years.}$

And  $3 R = \text{the Interest of 1 l. for three Years.}$

$4 R = \text{the Interest of 1 l. for four Years;}$   
and so on for any Number of Years propos'd.

Hence



Hence it is plain, That the Simple Interest of one Pound, is a Series of Terms in Arithmetical Progression increasing, whose first Term and common Difference is  $R$ , and the Number of all the Terms is  $t$ ; therefore the last Term will always be  $tR =$  the Interest of 1  $l.$  for any given Term signified by  $t$ .

Then  $\left\{ \begin{array}{l} \text{As one Pound is to the Interest of 1 } l. \text{ so is} \\ \text{any Principal or given Sum to its Interest.} \end{array} \right.$

That is,  $1 l. : tR :: P : tRP =$  the Interest of  $P$ ; then the Principal being added to its Interest, their Sum will be  $= A$ , the Amount required; which gives this general Theorem.

$$\text{Theorem } tRP + P = A.$$

From whence the three following Theorems are easily deduced.

$$\text{Theorem 2. } \left\{ \frac{A}{tR + 1} = P. \right.$$

$$\text{Theorem 3. } \left\{ \frac{A - P}{tP} = R. \right.$$

$$\text{Theorem 4. } \left\{ \frac{A - P}{RP} = t. \right.$$

These Four Theorems resolve all Questions about Simple Interest.

*Question I.* What will 256  $l.$  10  $s.$  amount to in 3 Years, 1 Quarter, 2 Months, and 18 Days, at 6 per Cent. per Ann.?

Here is given  $P = 256.5$ ,  $R = 0.06$ , And  $t = 3.46599$ ,

For 3 Years  $= 3$ ,

One Quarter  $= 0.25$ ,

Two Months  $= 0.16667 = 0.08333 \times 2$ .

Eighteen Days  $= 0.04932 = 0.00274 \times 18$ .

$$\text{Hence } t = 3.46599 \times 0.06 = 0.2079594 = tR.$$

$$\text{Then } 0.2079594 \times 256.5 = 53.341586 = tRP.$$

$$\text{And } 53.341586 + 256.5 = 309.841586 = tRP + P = A.$$

That is, 309  $l.$  16  $s.$  10  $d.$  being the Answer required.

*Question II.* What Principal or Sum being put to Interest, will raise a Stock of 309  $l.$  16  $s.$  10  $d.$  in 3 Years, 1 Quarter, 2 Months, and 18 Days, at 6 per Cent. per Ann.?

Or the same Question otherwise stated thus:

What is 309  $l.$  16  $s.$  10  $d.$  due 3 Years, 1 Quarter, 2 Months, and 18 Days hence, worth in Ready Money, abating or discounting 6 per Cent. &c.

Here is given  $A = 309.841586$ ,  $R = 0.06$ ,  $t = 3.46599$  (found as before) thence to find  $P$ , by Theorem 2.

$$\text{First, } 3.46599 \times 0.06 = 0.2079594 = tR.$$

$$\text{Then } tR + 1 = 1.2079594 \quad 309.841586 = A \quad (256.5 = P).$$

That is, 256  $l.$  10  $s.$  the Answer required.

*Question III.* At what Rate or Interest per Cent. &c. will 256  $l.$  10  $s.$  amount to 309  $l.$  16  $s.$  10  $d.$  in 3 Years, 1 Quarter, 2 Months, and 18 Days?

Here is given  $P = 256.5$ ,  $A = 309.841586$ , and  $t = 3.46599$ , to find  $R$  by Theorem 3.

$$\text{First, } 309.841586 - 256.5 = 53.341586 = A - P.$$

$$\text{Next, } 3.46599 \times 256.5 = 889.026435 = tR.$$

And  $tR = 889.026435 \div 53.341586 (00.06 =$  the Ratio.

Then  $1 l. 0.06 :: 100 : 6 =$  the Rate required.

*Question IV.* In what Time will 256  $l.$  10  $s.$  raise a Stock of (or Amount to) 309  $l.$  16  $s.$  10  $d.$  at 6 per Cent.?

Here is given  $P = 256.5$ ,  $A = 309.841586$ , and  $R = 0.06$ , to find  $t$  by Theorem 4.

$$\text{First, } 309.841586 - 256.5 = 53.341586 = A - P.$$

$$\text{And } 256.5 \times 0.06 = 15.39 = PR.$$

$$\text{Then } 15.39 \div 53.341586 (3.46599 = t.$$

That is,  $t = 3$  Years, and 46599 Decimal Parts of a Year; which may be brought into Common Parts of a Year, thus:

$$0.46599$$

$$0.25 = 1 \text{ Quarter.}$$

$$0.21599$$

$$\text{And } 0.08333 \div 0.21599 (2 \text{ Months.}$$

$$0.16666$$

$$0.02074 \div 0.04933 (18 \text{ Days.}$$

Hence  $t = 3$  Years, 1 Quarter, 2 Months, and 18 Days, the Answer required.

It must needs be easy to conceive, that what is here done at 6 per Cent. may be done at any other Rate of Interest, by forming the Ratio, viz.  $R$ , accordingly.

#### SCHOLIUM.

Altho' it be according to the Laws and Custom of England, to compute Interest at a certain Rate per Cent. per Ann. yet he that takes up Money at Interest for any Time less than even or compleat Years, pays more Interest than seems reasonably due, according to the Rules of Art.

As for Instance; If 100  $l.$  be forborn at Interest one whole Year at 6 per Cent. it amounts to 106  $l.$  But, I say, if it be paid at the Half-Year's End, it should not amount to 103  $l.$  as appears from this following Proportion:

Let  $a =$  the Amount due at the Half-Year's End; then it will be  $100 : a :: a : 106$ , the Amount at the Year's End: Ergo,  $a^2 = 10600$ ; and  $a = \sqrt{10600} = 102.9563 = 102 l. 19 s. 1 \frac{1}{2} d.$  which is less than 103  $l.$  by  $10 \frac{1}{2} d.$  And if it be paid in less than half a Year's time, the Error must needs be the greater.

#### Of ANNUITIES or Pensions in Arrears, computed at Simple Interest.

Annuities or Pensions, &c. are said to be in Arrears, when they are payable or due, either yearly or half-yearly, &c. and are unpaid for any Number of Payments. Therefore the Business is, to compute what all those Payments will amount unto, allowing any Rate of Simple Interest for their Forbearance, from the time each particular Payment became due. Now in order to that,

$u =$  the Annuity, Pension, or yearly Rent, &c.  
 $t =$  the Time of its Continuance, or being unpaid.  
 $R =$  the Ratio or Interest of 1  $l.$  for 1 Year, as before.  
 $A =$  the Amount of the Annuity and its Interest.

Then if  $u =$  the first Year's Rent, due without Interest;

And  $\left\{ \begin{array}{l} Ru = \text{the Interest} \\ 2u = \text{the Rent} \end{array} \right\}$  Due at the End of the second Year.

And  $\left\{ \begin{array}{l} 2Ru = \text{the Interest} \\ 3u = \text{the Rent} \end{array} \right\}$  Due at the End of the third Year.

And



And  $\begin{cases} 3Ru = \text{the Interest} \\ 4u = \text{the Rent} \end{cases}$  Due at the End of the fourth Year.  
 And  $\begin{cases} 4Ru = \text{the Interest} \\ 5u = \text{the Rent} \end{cases}$  Due at the End of the fifth Year.

And so on for any Number of Years. Hence it is evident, that  $Ru + 2Ru + 3Ru + 4Ru + 5u = A$  the Sum of all the Rents and their Interest, being forborn 5 Years.

From whence it follows, that  $Ru + 2Ru + 3Ru + 4Ru = A - tu$ . Here  $t = 5$ : Divide by  $u$ ; then  $R + 2R + 3R + 4R = \frac{A - tu}{u}$ .

Next, to find the Sum of this Progression thus:

$$\text{Theorem 1. } \left\{ \frac{ttRu - tRu + 2tu}{2} = A, \text{ or } \frac{ttu - tu}{2} \times R + tu = A. \right.$$

$$\text{Theorem 2. } \left\{ \frac{2A}{ttR - tR + 2t} = u. \right.$$

$$\text{Theorem 3. } \left\{ \frac{2A - 2tu}{ttu - tu} = R. \right.$$

$$\text{Let } \frac{2}{R} - 1 = x. \text{ Then } t = \sqrt{\frac{2A}{Ru} + \frac{xx}{4}} - \frac{x}{2} \text{ Theorem 4.}$$

*Question I.* If 250 *l.* yearly Rent (or Pension) be forborn or unpaid 7 Years, what will it amount to in that time, at 6 per Cent. for each Payment as it becomes due?

Here is given  $u = 250$ ,  $t = 7$ , and  $R = 0,06$ , to find  $A$  by Theorem 1.

First,  $250 \times 7 = 1750 = tu$ ,  $1750 \times 7 = 12250 = ttu$ . Again,  $12250 - 1750 = 10500 = ttu - tu$ , and  $\frac{10500}{2} \times 0,06 = 315$ .

Lastly,  $315 + 1750 = 2065 = A$ , viz. 2065 *l.* is the Answer required.

But if the Annuity, Rent, or Pension is to be paid by Quarterly or Half-yearly Payments, &c.

Then  $\frac{0,06}{2} = 0,03 = R$  for Half-yearly Payments,

And  $\frac{0,06}{4} = 0,015 = R$  for Quarterly; or 0,045 =  $R$  for three Quarterly Payments.

*Example of Half-yearly Payments.*

Suppose 250 *l.* per Annum, to be paid by Half-yearly Payments, were in Arrears or unpaid for 7 Years; what would it amount to, allowing 6 per Cent. per Ann. for each Payment as it becomes due?

There is given  $u = 125 = \frac{250}{2}$ ,  $t = 14$  the Number of Payments; And  $R = 0,03 = \frac{0,06}{2}$ , thence to find  $A$ .

First,  $125 \times 14 = 1750 = tu$ .  $1750 \times 14 = 24500 = ttu$ .

Again,  $24500 - 1750 = 22750 = ttu - tu$ . Then  $\frac{22750}{2} = 11375$ ,

And  $11375 \times 0,03 = 341,25$ . Lastly,  $341,25 + 1750 = 2091,25$ ; that is,  $A = 2091 \text{ l. } 5 \text{ s.}$

N. B. Hence it may be observed, that Half-yearly Payments are more advantageous than Yearly.

For 2091 *l.* 5 *s.* > 2065, by 26 *l.* 5 *s.* Consequently, Quarterly Payments are more advantageous than Half-yearly Payments.

*Question II.* What Yearly Rent, Pension, &c. being forborn or unpaid 7 Years, will raise a Stock of 2065 *l.* allowing 6 per Cent. per Ann. for each Payment as it becomes due?

Here is given  $A = 2065$ ,  $t = 7$ , and  $R = 0,06$ , to find  $u$ , by Theorem 2.

Let  $R + 2R + 3R + 4R$ , &c. =  $z$ ; then  $1 + 2 + 3 + 4$ , &c. =  $\frac{z}{R}$ . Here the Sum of the first and last Terms are  $4 + 1 = 5 = t$ . And the Number of all the Terms is  $4 = t - 1$ . Therefore  $\frac{t-1}{2} \times t =$  the Sum of all the Terms; that is,  $\frac{tt-t}{2} = \frac{z}{R}$ .

Hence  $\frac{ttR - tR}{2} = z$ . Consequently  $\frac{ttR - tR}{2} = \frac{A - tu}{u}$ . Now from this Equation it will be easy to deduce the following Theorems.

First,  $7 \times 0,06 = 0,42 = tR$ , and  $0,42 \times 7 = 2,94 = ttR$ . Then  $ttR - tR = 2,52$ .

Lastly,  $ttR - tR + 2t = 16,52$   $4130 = 2A$  ( $250 = u$ ).

That is, 250 *l.* per Ann. &c. will raise a Stock of 2065 *l.* required.

*Question. III.* In what Time will 250 *l.* Yearly Rent, raise a Stock of 2065 *l.* allowing 6 per Cent. &c. for the Forbearance of the Payments as they become due?

Here is given  $u = 250$ ,  $A = 2065$ , and  $R = 0,06$ , to find  $t$  by Theorem 4.

First,  $\frac{2}{R} = \frac{2}{0,06} = 33,3333$ , and  $33,3333 - 1 = 32,3333 = x = \frac{2}{R} - 1$ .

Then  $16,16666$ , &c. =  $\frac{x}{2}$ ,  $261,3605$ , &c. =  $\frac{x^2}{4}$

Again;  $\frac{4132}{15} = 275,333 = 2A \div Ru$ ; and  $275,3333 + 261,3605 = 536,6938 = \frac{2A}{Ru} + \frac{xx}{4}$ ,

Then  $\sqrt{536,6938} = 23,1666$ ; Lastly,  $23,1666 - 1666 = 7 = t$ , the Time required.

*Question IV.* If 250 *l.* Yearly Rent, being forborn 7 Years, will amount to 2065 *l.* allowing Simple Interest for every Payment as it becomes due, what must the Rate of the Interest be per Cent.?

Here is given  $u = 250$  *l.*  $A = 2065$ , and  $t = 7$ , to find  $R$  by Theorem 3.

Thus  $\begin{cases} ttu = 12250. & 4130 = 2A \\ -tu = 1750. & 3500 = 2tu. \end{cases}$

$ttu - tu = 10500$   $630 = 2A - 2tu$  ( $0,06 = R$ ).

Then  $1 : 0,06 :: 100 : 6$ , the Rate required.

*The Present Worth of ANNUITIES, or Pensions, &c. computed at Simple Interest.*

The Business of purchasing Annuities, or taking of Leases, &c. for any assigned Time, depends upon the true equating of the Principal or Money laid out on the Purchase, with the Annuity or Yearly Rent, by allowing (or discounting) the same Rate of Interest to both Parties: Which may be easily performed, by duly applying the respective Theorems



rents of the two last Sections together; as will fully appear by the following Question.

*Question I.* What is 75*l.* Yearly Rent, to continue nine Years, worth in Ready Money, at 6 per

$$\text{Thus } u = 75, t = 9.$$

$$tu = 675$$

$$tu = 675$$

$$tu - tu = 5400$$

$$\text{And } R = 0,06$$

$$\text{Then } 2) 5400 (2700 \left. \begin{array}{l} \text{Quare } A. \\ \text{Multiply} \end{array} \right\}$$

$$R = 0,06$$

$$+ tu = 675, \left. \begin{array}{l} 162, \\ \end{array} \right\} = 837 = A.$$

Then by Theorem 2. Section 1. find what Principal, being put to Interest for the same Time, and at the same Rate, will amount to 837*l.* = *A.*

$$\text{Thus, } tR = 0,54 = 9 \times 0,06, tR + 1 = 1,54) 837 (543,5064 = P.$$

That is, *P* = 543*l.* 10*s.* 1½*d.* which is the Worth of 75*l.* a Year; as was required.

From the Work of these two Operations, (duly

$$\text{Theorem 1. } \left\{ \frac{tuRu - tRu + 2tu}{2tR + 2} = P. \text{ Or } \frac{tR - tR + 2t}{2tR + 2} : u = P. \right.$$

By this Theorem all Questions of the same kind with the last, (*viz.* that above) may be easily and readily answered at one Operation.

$$\text{Theorem 2. } \left\{ \frac{2PtR + 2P}{tuR - tR + 2t} = u. \text{ Or } \frac{tR + 1}{tuR - tR + 2t} : 2P = u. \right.$$

$$\text{Theorem 3. } \left\{ \frac{2P - 2tu}{tu - tu - 2Pt} = R, \text{ Let } \frac{2}{R} - \frac{2P}{u} - 1 = x; \text{ then will } tu \pm xt = \frac{2P}{Ru} : \right.$$

Which gives this

$$\text{Theorem 4. } \left\{ \sqrt{\frac{2P}{Ru} + \frac{x^2}{4}} : \pm \frac{x}{2} = t. \right.$$

By the second and fourth Theorems, two very useful Questions may be easily answered.

1. As for Instance; If it be required to find what Annuity, or Yearly Rent, &c. may be purchased, for any propos'd Sum, to continue any assigned Time, allowing any Rate of Interest.

This Question may be answered by Theorem 2.

2. Again; If it be required to find how long any Yearly Rent, Pension, or Annuity, &c. may be purchased (or enjoyed) for any propos'd Sum, at any given Rate of Interest.

All Questions of this kind are easily answered by Theorem 4.

II. *Interest Compound*, is that which arises from any *Principal* and its *Interest* put together, as the *Interest* still becomes due; so that at every Payment, or at the *Time* when the Payments became due, there is created a *new Principal*; and for that Reason it is called *Interest upon Interest*, or *Compound Interest*.

As for Instance; Suppose 100*l.* were lent out for two Years, at 6 per Cent. per Ann. Compound Interest; then at the End of the first Year, it will only amount to 106*l.* as in Simple Interest: But for the second Year, this 106*l.* becomes Principal, which will amount to 112*l.* 7*s.* 2½*d.* at the second Year's End; whereas by Simple Interest it would have amounted to but 112*l.*

And altho' it be not lawful to lett out Money at Compound Interest, yet in purchasing Annuities or Pensions, &c. and taking Leases in Reversion, it is very usual to allow Compound Interest to the Purchaser for his Ready Money; and therefore it is very requisite to understand it. In order to which,

Cent. per Ann. Simple Interest?

1. By Theorem 1. of the last Section, find what the propos'd Yearly Rent would amount to, if it were forborn 9 Years at 6 per Cent.

$$\text{Quare } A.$$

$$\text{Then } 2) 5400 (2700 \left. \begin{array}{l} \text{Quare } A. \\ \text{Multiply} \end{array} \right\}$$

$$R = 0,06$$

$$+ tu = 675, \left. \begin{array}{l} 162, \\ \end{array} \right\} = 837 = A.$$

considered) it must needs be easy to conceive how the two Theorems, by which they were perform'd, may be combined into one.

$$\text{For 1. } \frac{tuRu - tRu + 2tu}{2} = A. \text{ And 2. } PtR + P = A.$$

$$\text{Consequently, } PtR + P = \frac{tuRu - tRu + 2tu}{2},$$

And from this Equation may be deduced the following Theorems.

Let  $\left\{ \begin{array}{l} P = \text{the Principal put to Interest.} \\ t = \text{the Time of its Continuance.} \\ A = \text{the Amount of the Principal and Inter.} \\ R = \left\{ \begin{array}{l} \text{the Amount of 1 l. and its Interest for} \\ \text{1 Year, at any given Rate, which may} \\ \text{be thus found:} \end{array} \right. \end{array} \right\} \text{As before}$

*Viz.* 100 : 106 :: 1 : 1,06 = the Amount of 1*l.* at 6 per Cent.

Or, 100 : 105 :: 1 : 1,05 = the Amount of 1*l.* at 5 per Cent.

And so on for any other assigned Rate of Interest.

Then if *R* = the Amount of 1*l.* for One Year, at any Rate.

*RR* = the Amount of 1*l.* for Two Years.

*R*<sup>3</sup> = the Amount of 1*l.* for Three Years.

*R*<sup>4</sup> = the Amount of 1*l.* for Four Years.

*R*<sup>5</sup> = the Amount of 1*l.* for Five Years.

Here *t* = 5.

$$\text{For } 1 : R :: R : RR :: RR : RRR :: RRR : R^4 ::$$

$$R^4 : R^5 : \&c.$$

That is,  $\left\{ \begin{array}{l} \text{As One Pound : Is to the Amount of One} \\ \text{Pound at one Year's End : : So is that} \\ \text{Amount : To the Amount of One Pound} \\ \text{at two Years End, \&c.} \end{array} \right.$

Whence it is plain, that Compound Interest is grounded upon a Series of Terms, increasing, in Geometrical Proportion continued; wherein *t* (*viz.* the Number of Years) does always assign the Index of the last and highest Term.

*Viz.* The Power of *R*, which is *R*<sup>*t*</sup>.

Again; As 1 : *R*<sup>*t*</sup> :: *P* : *P**R*<sup>*t*</sup> = *A* the Amount of *P* for the Time, that *R*<sup>*t*</sup> = the Amount of 1*l.*

That is,  $\left\{ \begin{array}{l} \text{As One Pound : Is to the Amount of One} \\ \text{Pound for any given Time : : So is any} \\ \text{proposed Principal, or Sum : To its Amount} \\ \text{for the same Time.} \end{array} \right.$



Ex. 1. *What is 30l. Yearly Rent, to continue 7 Years, worth in ready Money, allowing 6 per Cent. Compound Interest to the Purchaser?*

Here is given  $u = 30$ ,  $t = 7$ , and  $R = 1.06$ . to find  $P$  by Theorem 1, viz.  $\frac{u}{R^t} = \frac{30}{1.50363} = 19.9517$ .

And  $30 - 19.9517 = 10.0483 = u - \frac{u}{R^t}$ .

$$\begin{aligned} \text{First } PR^t \times R &= 251.8153 \times 1.06 = 266.9242. \\ \text{And } -PR^t &= 167.4716 \times 1.50363 = 251.8153. \end{aligned}$$

Then  $R^t - 1 = 0.50363$  )  $15.1089 (30 = u$ .  
That is,  $u = 30$  l. the Answer required.

Ex. 3. *How long may one have a Lease of 30l. Yearly Rent, for 167l. 9s. 5d. allowing 6 per Cent. Compound Interest to the Purchaser?*

Here is given  $P = 167.4716$ ,  $u = 30$ , and  $R = 1.06$ . to find  $t$  by the third Theorem.

$$\text{First } P + u = 167.4716 + 30 = 197.4716.$$

$$\text{And } -PR = 177.5199.$$

$$\text{Then } 19.9515) 30 = u (1.50363 = R^t.$$

If this  $1.50363 = R^t$  be either continually divided by  $1.06 = R$  until nothing remain; or if it be sought in the Table of Amounts for Years, &c. it will discover  $t = 7$ , which is the true Answer required.

Ex. 4. *Suppose one should give 167l. 9s. 5d. for the Purchase of a Pension or Annuity of 30l. per Ann. to continue Seven Years, At what Rate of Interest per Cent. would that Purchase be made, allowing Compound Interest to the Purchaser?*

In this Question there is given  $P = 167.4716$ ,  $u = 30$ , and  $t = 7$ ; to find  $R$  by Theorem 4.

The 4th Theorem is this Equation  $\frac{u}{P} = \frac{u}{P} R^t + R^t - R^{t+1}$  which being brought into Numbers, and its Root extracted, as in the 4th Example of Annuities in Arrear, the Value of  $R$  will be found  $1.06$ ; viz.  $R = 1.06$ .

And then it will be,  $1 : 0.06 :: 100 : 6$ , the Rate per Cent. as was required.

These four Examples include all the Varieties that can be proposed about purchasing Annuities or Leases, &c. which are to be either immediately entered upon, or in Possession at the Time when the Purchase is made.

But such Questions as relate to Annuities, or taking of Leases, &c. in Reversion, must be divided into two distinct Questions; as in the following Examples.

Ex. 1. *Suppose it were required to compute the present Worth of 75l. Yearly Rent, which is not to commence or be entered upon until 10 Years hence; and then to continue Seven Years after that Time, at 6 per Cent. &c. Compound Interest.*

$$\begin{aligned} \text{Thus, } PR^t \times R &= 418.6783 \times 1.50363 \times 1.06 = 667.3095 \\ -PR^t &= 418.6783 \times 1.50363 = 629.5372 \end{aligned}$$

$$R^t - 1 = 0.50363) 37.7723 (75 = u.$$

That is,  $u = 75$  l. the Yearly Rent required by the Question.

These two Examples of finding  $P$  and  $u$ , do fully shew the Method in resolving the two general and most useful Questions about Annuities or Leases in Reversion: And if there be Occasion, either the Rate or the Time, viz.  $R$  or  $t$ , may be found by a due Application of their respective Theorems.

Now tho' I have given Theorems relating to the Purchase of Annuities at Simple Interest, yet I would advise all Purchasers not to lay out their Money on

Then  $R - 1 = 0.06$  )  $10.0483 (167.4716 = P = 167$  l. 9s. 5d. being the Answer required.

Ex. 2. *What Annuity or Yearly Rent, to continue 7 Years, may be purchas'd for 167l. 9s. 5d. allowing 6 per Cent. Compound Interest to the Purchaser?*

In this Question there is given  $P = 167.4716$ ,  $t = 7$ , and  $R = 1.06$ . to find  $u$  by the second Theorem.

First, Find what 75 l. per Annum, to continue Seven Years, is worth in Ready Money, as if it were to be immediately entered upon: And to perform that, there is given  $u = 75$ ,  $R = 1.06$ ; and  $t = 7$ ; to find  $P$  by Theorem 1. above.

$$\begin{aligned} \text{Thus } \frac{u}{R^t} &= \frac{75}{1.50363} = 49.8793, \text{ and } 75 - 49.8793 \\ &= 25.1207 = u - \frac{u}{R^t}. \end{aligned}$$

Then,  $R - 1 = 0.06$  )  $25.1207 (= 418.6783 = 418$  l. 14s. 6 $\frac{3}{4}$ d. the Answer to the first Part of the Question.

Then find what Principal or Sum put out 10 Years, at 6 per Cent. &c. will amount to 418 l. 14s. 6 $\frac{3}{4}$ d. Here is given  $A = 418.6783$ ,  $R = 1.06$ , and  $t = 10$ , to find  $P$ .

Thus,  $R^{10} = 1.7908$  )  $418.6783 = A (233.7884 = 233$  l. 15s. 9d. the present Worth of 75 l. per Ann. in Reversion, &c. as was required.

Ex. 2. *What Annuity or Yearly Rent to be enter'd upon 10 Years hence, and then to continue 7 Years, may be purchas'd for 233l. 15s. 9d. Ready Money, at 6 per Cent. &c. Compound Interest?*

Here is given  $P = 233.7884$ ,  $R = 1.06$ , and  $t = 10$  (the Time which the Annuity is not to be entered upon) to find  $A$ .

Thus,  $PR^t = 233.7884 \times 1.790847 = 418.6783 = A$ , the Amount of 233 l. 15s. 9d. put to Interest 10 Years, at 6 per Cent. &c. then there is given  $P = 418.6783$ ,  $R = 1.06$ , and  $t = 7$  (the Time that the Annuity is to be enjoyed) to find  $u$ .

such Terms; for if they do, they must certainly be Losers, as appears by the following

Example, *What is the present Worth of an Annuity of 50l. per Annum, to continue 40 Years, allowing the Purchaser 5 per Cent. per Annum for his Money?*

Here is given  $u = 50$ ,  $t = 40$ ; and  $R = 0.05$ , to find  $A$ .

Then



Then by *Theorem 1.*  $\frac{ttRu - tRu + 2tu}{2tR + 2} =$   
 $\frac{4000 - 100 + 4000}{4 + 2} = 1316,6666 = 1316 \text{ l. } 13 \text{ s. } 4 \text{ d.}$   
 the present Worth required.

Now 1316 l. 13 s. 4 d. laid out at Interest at 5 per Cent. per Ann. will bring in 65 l. 16 s. 8 d. per Ann. which is 15 l. 16 s. 8 d. per Ann. more than the Purchaser has by his Annuity; and therefore I think he would have made a bad Purchase, to have given a Sum for the Purchase of an Annuity of 50 l. per Ann. only for 40 Years; which, if laid out at Interest, would have brought him and his Heirs in 65 l. 16 s. 8 d. per Ann. for ever, supposing the Rate of Interest to continue at 5 per Cent. per Ann.

### Of purchasing Freehold, Or Real Estates at Compound Interest.

All Freehold or Real Estates, are suppos'd to be purchased or bought to continue for ever (viz. without any limited Time) therefore the Business of computing the Value of such Estates, is grounded upon a Rank or Series of Geometrical Proportionals, continually decreasing, *ad infinitum*.

Thus, let  $P, u, R$ , denote the same Data as before; then the Series will be  $\frac{u}{R} \cdot \frac{u}{R^2} \cdot \frac{u}{R^3} \cdot \frac{u}{R^4} \cdot \frac{u}{R^5} \cdot$  and so on in  $\div$  untill the last Term  $= 0$ . Then will  $P - 0$  (viz.  $P$ ) be the Sum of all the Antecedents, and  $P - \frac{u}{R}$  will be the Sum of all the Consequents:

Therefore it will be  $u : \frac{u}{R} :: P : P - \frac{u}{R}$ , which produces  $PR - u = P$ .

This Equation affords these following Theorems.

*Theorem 1.*  $PR - P = u$ .

*Theorem 2.*  $\left\{ \frac{u}{R - 1} = P \right.$

*Theorem 3.*  $\left\{ \frac{P + u}{P} = R \right.$

Example. Suppose a Freehold Estate of 75 l. Yearly Rent were to be sold, What is it worth, allowing the Buyer 6 per Cent. &c. Compound Interest for his Money?

In this Question there is given  $u = 75$ ,  $R = 1,06$ , to find  $P$  by *Theorem 2.* Thus  $R - 1 = 0,06$   $75 = u$  (1250 l.  $= P$ , the Answer required; and so for any of the rest, as Occasion requires: But if the Rent is to be paid either by Quarterly or Half-Yearly Payments,

Then  $R = \sqrt{1,06}$  for Half-Yearly } Payments at  
 And  $R = \sqrt[4]{1,06}$  for Quarterly } 6 per Cent.

Or  $\left\{ \begin{array}{l} R = 1,05 \text{ for Yearly} \\ R = \sqrt{1,05} \text{ for Half-Yearly} \\ R = \sqrt[4]{1,05} \text{ for Quarterly} \end{array} \right\}$  Payments at  
 5 per Cent.

The like is to be understood for any proposed Rate of Interest, either greater or less than 6 per Cent.

The very Ingenious and Learned Captain Halley hath, in his Observations on the Breslaw Bills of Mortality, (in *Philos. Transf.* N. 196.) shewed several Ways of estimating the Values of Annuities and Lives, and computing the different Degrees of Mortality, or rather, as he calls it, Vitality; where he proves, That 'tis 80 to 1, that a Person of 25 Years old doth not die in a Year: That 'tis 5 and a half to one, a Man of 40 lives 7 Years: That a Man of 30 may reasonably expect to live between 27 and 28 Years, &c. And he gives Rules for the Valuation of 2, 3, or more Lives, and what an Annuity is worth during the Continuance of any of them, &c.

INTEREST. Besides the Ways of computing Interest, both Simple and Compound, before deliver'd, I shall here give you another very plain, easy and ready Method of computing all Simple Interest and Discount; as also the Way to find the Amount or present Value of any Sum of Money; or of any Annuity, or other Yearly Payment, &c. for any Term, not exceeding an Hundred Years. And this from the accurate and useful Tables of Mr. John Smart, of the Town-Clerk's Office in London. And in order to this, the following Table of Shillings, Pence and Farthings, reduc'd to the Decimal Parts of a Pound, are previously necessary.



# SHILLINGS, PENCE, and FARTHINGs, reduced to the Decimal Parts of a POUND.

s.	d.	Decimal Parts of a Pound.	s.	d.	Decimal Parts of a Pound.	s.	d.	Decimal Parts of a Pound.	s.	d.	Decimal Parts of a Pound.
—	—	—	—	—	—	—	—	—	—	—	—
—	$\frac{1}{4}$	.001042	—	$7\frac{1}{4}$	.030208	- I	$2\frac{1}{4}$	.059375	- I	$9\frac{1}{2}$	.089583
—	$\frac{1}{2}$	.002083	—	$7\frac{1}{2}$	.03125	- I	$2\frac{1}{2}$	.060417	- I	$9\frac{3}{4}$	.090625
—	$\frac{3}{4}$	.003125	—	$7\frac{3}{4}$	.032292	- I	$2\frac{3}{4}$	.061458	- I	10	.091667
—	- I	.004167	—	- 8	.033333	- I	- 3	.0625	- I	$10\frac{1}{4}$	.092708
—	$- I\frac{1}{4}$	.005208	—	$- 8\frac{1}{4}$	.034375	- I	$- 3\frac{1}{4}$	.063542	- I	$10\frac{1}{2}$	.09375
—	$- I\frac{1}{2}$	.00625	—	$- 8\frac{1}{2}$	.035417	- I	$- 3\frac{1}{2}$	.064583	- I	$10\frac{3}{4}$	.094792
—	$- I\frac{3}{4}$	.007292	—	$- 8\frac{3}{4}$	.036458	- I	$- 3\frac{3}{4}$	.065625	- I	11	.095833
—	- 2	.008333	—	- 9	.0375	- I	- 4	.066667	- I	$11\frac{1}{4}$	.096875
—	$- 2\frac{1}{4}$	.009375	—	$- 9\frac{1}{4}$	.038542	- I	$- 4\frac{1}{4}$	.067708	- I	$11\frac{1}{2}$	.097917
—	$- 2\frac{1}{2}$	.010417	—	$- 9\frac{1}{2}$	.039583	- I	$- 4\frac{1}{2}$	.06875	- I	$11\frac{3}{4}$	.098958
—	$- 2\frac{3}{4}$	.011458	—	$- 9\frac{3}{4}$	.040625	- I	$- 4\frac{3}{4}$	.069792	- 2	—	.1
—	- 3	.0125	—	10	.041667	- I	- 5	.070833	- 3	—	.15
—	$- 3\frac{1}{4}$	.013542	—	$10\frac{1}{4}$	.042708	- I	$- 5\frac{1}{4}$	.071875	- 4	—	.2
—	$- 3\frac{1}{2}$	.014583	—	$10\frac{1}{2}$	.04375	- I	$- 5\frac{1}{2}$	.072917	- 5	—	.25
—	$- 3\frac{3}{4}$	.015625	—	$10\frac{3}{4}$	.044792	- I	$- 5\frac{3}{4}$	.073958	- 6	—	.3
—	- 4	.016667	—	11	.045833	- I	- 6	.075	- 7	—	.35
—	$- 4\frac{1}{4}$	.017708	—	$11\frac{1}{4}$	.046875	- I	$- 6\frac{1}{4}$	.076042	- 8	—	.4
—	$- 4\frac{1}{2}$	.01875	—	$11\frac{1}{2}$	.047917	- I	$- 6\frac{1}{2}$	.077083	- 9	—	.45
—	$- 4\frac{3}{4}$	.019792	—	$11\frac{3}{4}$	.048958	- I	$- 6\frac{3}{4}$	.078125	10	—	.5
—	- 5	.020833	- I	—	.05	- I	- 7	.079167	11	—	.55
—	$- 5\frac{1}{4}$	.021875	- I	$-\frac{1}{4}$	.051042	- I	$- 7\frac{1}{4}$	.080208	12	—	.6
—	$- 5\frac{1}{2}$	.022917	- I	$-\frac{1}{2}$	.052083	- I	$- 7\frac{1}{2}$	.08125	13	—	.65
—	$- 5\frac{3}{4}$	.023958	- I	$-\frac{3}{4}$	.053125	- I	$- 7\frac{3}{4}$	.082292	14	—	.7
—	- 6	.025	- I	- I	.054167	- I	- 8	.083333	15	—	.75
—	$- 6\frac{1}{4}$	.026042	- I	$- I\frac{1}{4}$	.055208	- I	$- 8\frac{1}{4}$	.084375	16	—	.8
—	$- 6\frac{1}{2}$	.027003	- I	$- I\frac{1}{2}$	.05625	- I	$- 8\frac{1}{2}$	.085417	17	—	.85
—	$- 6\frac{3}{4}$	.028125	- I	$- I\frac{3}{4}$	.057292	- I	$- 8\frac{3}{4}$	.086458	18	—	.9
—	- 7	.029167	- I	- 2	.058333	- I	- 9	.0875	19	—	.95
—	—	—	—	—	—	- I	$- 9\frac{1}{4}$	.088542	—	—	—

## Examples of the Use of the preceding Table.

What Decimal Part of a Pound is 7d?

Look in the Table for 7d. and even with it you will find .029167, which is the Decimal required.

What Decimal Part of a Pound is 17s. 6d.?

You will find the Decimal of 17s. to be .85, and the Decimal of 6d. to be .025; which added, makes .875, and answers the Question.

What is the Value of this Decimal .09375 in Shillings, Pence and Farthings?

Look in the Table, and you will find it to be 1s. 10d.  $\frac{1}{2}$ .

*Note*, If you cannot find in the Table the exact Decimal sought for, take that which is nearest to it, and you can never err above half a Farthing.

Knowing thus the Use of these Decimal Tables, all the Business of *Simple Interest* will very easily be understood and dispatch'd as followeth.

## Simple Interest.

The *Yearly Interest* of any Sum of Money is had, by only multiplying the *Principal* Sum by the *Hundredth* part of the *Rate* of Interest: For the Product in Decimals is the true Answer.

## Examples.

1. *What is the Interest of 75 Pounds for one Year, at the Rate of 6l. per Cent.*

75 = Principal.

.06 = the Hundredth part of 6l.

4.50 the Product; which is 4 10 00

2. *What is the Yearly Interest of 157l. 17s. 6d. at 5l. per Cent.?*

157.875 is the Decimal for 157l. 17s. 6d.

.05 the Hundredth part of 5 Pounds.

7.89375 which is the Decimal answering to 7l. 17s. 10d.  $\frac{1}{2}$ ; the Interest of 157l. 17s. 6d. for one Year at 5l. per Cent.

And



And so for any other *Rate* or *Sum* whatsoever.

When thus the *Interest* for one Year is found, divide it by 365; the *Quotient* will be the *Interest* for one Day.

Thus .01 being the *Interest* of one Pound for one Year; if you Divide that Decimal by 365 (continuing the Work as long as you please) you will have .00002739726028, &c. ——— for a *Quotient*; which will be the *Interest* of one Pound for one Day; and at one per Cent.

Then will this Decimal .000027, &c. found as above; if you multiply it continually by the *Principal*, the *Number of Days*, and the *Rate of Interest*, become of itself an *Interest Table* for any *Sum* of Money, for any *Time*, and at any *Rate*.

Example.

What is the *Interest* of 150 l. for 365 Days, at 6 l. per Cent.?

```

.00002739726028
  150
-----
410958904200
  365
-----
150000000033000
    6
-----
9.00000000198000
    
```

Which Decimal gives the Answer near enough for any Use, to be 9 Pounds.

By the same Rule .02 divided by 365, will give in the *Quotient* the *Interest* of one Pound for one Day, at 2 per Cent. and .03 divided by 365, will do the same at 3 per Cent. And thus these Numbers following were found.

The *Interest* of one Pound for one Day, at all Rates, from 1, to 10 per Cent.

At 1 l. per Cent. is .000027397260 &c. as above.

```

2----- .000054794512
3----- .000082191781
4----- .000109589041
5----- .000136986301
6----- .000164383562
7----- .000191780822
8----- .000219178082
9----- .000246575342
10----- .000273972603
          &c.
    
```

And when thus the *Interest* of one Pound for one Day, and at any *Rate*, is found; then that *Interest* multiplied by 2, 3, 4, 5, 6, 7, 8, and 9, &c. gives the *Interest* of any *Sum* of Money, at the same *Rate*.

Take an Example at 3 l. per Cent.

*Interest* of 1 l. for one Day, is .00008219178

```

2----- .00016438356
3----- .00024657534
4----- .00032876712
5----- .00041095890
6----- .00049315068
7----- .00057534246
8----- .00065753424
9----- .00073972602
    
```

And then 'tis easy to find, that the *Interest* of 1 l. being, as before, .000082, &c. that of

```

10 will be .000822*
100----- .008219
1000----- .082192*
10000----- .821918*
100000----- 8.219178
1000000----- 82.191781
    
```

Because moving the Point of Separation still one Place nearer to the Left Hand, multiplies any Decimal by 10, 100, 1000, &c. as is shewn under *Decimals*.

And thus the following Tables of *Daily Interest* were made.

The Reasons of the Stars above, set to some of the Numbers, is only to shew that in the *Contraction* of a Decimal Fraction to fewer Places, it is proper to add one to the last Figure retain'd, when the next Figure to it, which is omitted, exceeded 5.



I N T

I N T

**INTEREST for One Day, at 3, 4, 5, and 6 Pound *per Cent.*  
*per Annum.***

<i>At 3 l. per Cent. per An.</i>		<i>At 4 l. per Cent. per An.</i>		<i>At 5 l. per Cent. per An.</i>		<i>At 6 l. per Cent. per An.</i>	
Principal.	Interest.	Principal.	Interest.	Principal.	Interest.	Principal.	Interest.
10000000	821.9178	10000000	1095.8904	10000000	1369.8630	10000000	1643.8356
9000000	739.7260	9000000	986.3014	9000000	1232.8767	9000000	1479.4521
8000000	657.5342	8000000	876.7123	8000000	1095.8904	8000000	1315.0685
7000000	575.3425	7000000	767.1233	7000000	958.9041	7000000	1150.6849
6000000	493.1507	6000000	657.5342	6000000	821.9178	6000000	986.3014
5000000	410.9589	5000000	547.9452	5000000	684.9315	5000000	821.9178
4000000	328.7671	4000000	438.3562	4000000	547.9452	4000000	657.5342
3000000	246.5753	3000000	328.7671	3000000	410.9589	3000000	493.1507
2000000	164.3836	2000000	219.1781	2000000	273.9726	2000000	328.7671
1000000	82.1918	1000000	109.5890	1000000	136.9863	1000000	164.3836
900000	73.9726	900000	98.6301	900000	123.2877	900000	147.9452
800000	65.7534	800000	87.6712	800000	109.5890	800000	131.5068
700000	57.5342	700000	76.7123	700000	95.8904	700000	115.0685
600000	49.3151	600000	65.7534	600000	82.1918	600000	98.6301
500000	41.0959	500000	54.7945	500000	68.4932	500000	82.1918
400000	32.8767	400000	43.8356	400000	54.5945	400000	65.7534
300000	24.6575	300000	32.8767	300000	41.0959	300000	49.3151
200000	16.4384	200000	21.9178	200000	27.3973	200000	32.8767
100000	8.2192	100000	10.9589	100000	13.6986	100000	16.4384
90000	7.3973	90000	9.8630	90000	12.3288	90000	14.7945
80000	6.5753	80000	8.7671	80000	10.9589	80000	13.1507
70000	5.7534	70000	7.6712	70000	9.5890	70000	11.5068
60000	4.9315	60000	6.5753	60000	8.2192	60000	9.8630
50000	4.1096	50000	5.4795	50000	6.8493	50000	8.2192
40000	3.2877	40000	4.3836	40000	5.4795	40000	6.5753
30000	2.4658	30000	3.2877	30000	4.1096	30000	4.9315
20000	1.6438	20000	2.1918	20000	2.7397	20000	3.2877
10000	.8219	10000	1.0959	10000	1.3699	10000	1.6438
9000	.7397	9000	.9863	9000	1.2329	9000	1.4795
8000	.6575	8000	.8767	8000	1.0959	8000	1.3151
7000	.5753	7000	.7671	7000	.9589	7000	1.1507
6000	.4932	6000	.6575	6000	.8219	6000	.9863
5000	.4110	5000	.5479	5000	.6849	5000	.8219
4000	.3288	4000	.4384	4000	.5479	4000	.6575
3000	.2466	3000	.3288	3000	.4110	3000	.4932
2000	.1644	2000	.2192	2000	.2740	2000	.3288
1000	.0822	1000	.1096	1000	.1370	1000	.1644
900	.0740	900	.0986	900	.1233	900	.1479
800	.0658	800	.0877	800	.1096	800	.1315
700	.0575	700	.0767	700	.0959	700	.1151
600	.0493	600	.0658	600	.0822	600	.0986
500	.0411	500	.0548	500	.0685	500	.0822
400	.0329	400	.0438	400	.0548	400	.0658
300	.0247	300	.0329	300	.0411	300	.0493
200	.0164	200	.0219	200	.0274	200	.0329
100	.0082	100	.0110	100	.0137	100	.0164
90	.0074	90	.0099	90	.0123	90	.0148
80	.0066	80	.0088	80	.0110	80	.0132
70	.0058	70	.0077	70	.0096	70	.0115
60	.0049	60	.0066	60	.0082	60	.0099
50	.0041	50	.0055	50	.0068	50	.0082
40	.0033	40	.0044	40	.0055	40	.0066
30	.0025	30	.0033	30	.0041	30	.0049
20	.0016	20	.0022	20	.0027	20	.0033
10	.0008	10	.0011	10	.0014	10	.0016
9	.0007	9	.0010	9	.0012	9	.0015
8	.0007	8	.0009	8	.0011	8	.0013
7	.0006	7	.0008	7	.0010	7	.0012
6	.0005	6	.0007	6	.0008	6	.0010
5	.0004	5	.0005	5	.0007	5	.0008
4	.0003	4	.0004	4	.0005	4	.0007
3	.0002	3	.0003	3	.0004	3	.0005
2	.0002	2	.0002	2	.0003	2	.0003
1	.0001	1	.0001	1	.0001	1	.0002

INTEREST



# INTEREST for One Day, at 7, 8, 9, and 10 Pound per Cent. per Annum.

At 7 l. per Cent. per An.		At 8 l. per Cent. per An.		At 9 l. per Cent. per An.		At 10 l. per Cent. per An.	
Principal.	Interest.	Principal.	Interest.	Principal.	Interest.	Principal.	Interest.
10000000	1917.8082	10000000	2191.7808	10000000	2465.7534	10000000	2739.7260
9000000	1726.0274	9000000	1972.6027	9000000	2219.1781	9000000	2465.7534
8000000	1534.2466	8000000	1753.4247	8000000	1972.6027	8000000	2191.7808
7000000	1342.4658	7000000	1534.2466	7000000	1726.0274	7000000	1917.8082
6000000	1150.6849	6000000	1315.0685	6000000	1479.4521	6000000	1643.8356
5000000	958.9041	5000000	1095.8904	5000000	1232.8767	5000000	1369.8630
4000000	767.1233	4000000	876.7123	4000000	986.3014	4000000	1095.8904
3000000	575.3425	3000000	657.5342	3000000	739.7260	3000000	821.9178
2000000	383.5616	2000000	438.3562	2000000	493.1507	2000000	547.9452
1000000	191.7808	1000000	219.1781	1000000	246.5753	1000000	273.9726
900000	172.6027	900000	197.2603	900000	221.9178	900000	246.5753
800000	153.4247	800000	175.3425	800000	197.2603	800000	219.1781
700000	134.2466	700000	153.4247	700000	172.6027	700000	191.7808
600000	115.0685	600000	131.5068	600000	147.9452	600000	164.3836
500000	95.8904	500000	109.5890	500000	123.2877	500000	136.9863
400000	76.7123	400000	87.6712	400000	98.6301	400000	109.5890
300000	57.5342	300000	65.7534	300000	73.9726	300000	82.1918
200000	38.3562	200000	43.8356	200000	49.3151	200000	54.7945
100000	19.1781	100000	21.9178	100000	24.6575	100000	27.3973
90000	17.2603	90000	19.7260	90000	22.1918	90000	24.6575
80000	15.3425	80000	17.5342	80000	19.7260	80000	21.9178
70000	13.4247	70000	15.3425	70000	17.2603	70000	19.1781
60000	11.5068	60000	13.1507	60000	14.7945	60000	16.4384
50000	9.5890	50000	10.9589	50000	12.3288	50000	13.6986
40000	7.6712	40000	8.7671	40000	9.8630	40000	10.9589
30000	5.7534	30000	6.5753	30000	7.3973	30000	8.2192
20000	3.8356	20000	4.3836	20000	4.9315	20000	5.4795
10000	1.9178	10000	2.1918	10000	2.4658	10000	2.7397
9000	1.7260	9000	1.9726	9000	2.2192	9000	2.4658
8000	1.5342	8000	1.7534	8000	1.9726	8000	2.1918
7000	1.3425	7000	1.5342	7000	1.7290	7000	1.9178
6000	1.1507	6000	1.3151	6000	1.4795	6000	1.6438
5000	.9589	5000	1.0959	5000	1.2329	5000	1.3699
4000	.7671	4000	.8767	4000	.9863	4000	1.0959
3000	.5753	3000	.6575	3000	.7397	3000	.8219
2000	.3836	2000	.4384	2000	.4932	2000	.5479
1000	.1918	1000	.2192	1000	.2466	1000	.2740
900	.1726	900	.1973	900	.2219	900	.2466
800	.1534	800	.1753	800	.1973	800	.2192
700	.1342	700	.1534	700	.1726	700	.1918
600	.1151	600	.1315	600	.1479	600	.1644
500	.0959	500	.1096	500	.1233	500	.1370
400	.0767	400	.0877	400	.0986	400	.1096
300	.0575	300	.0658	300	.0740	300	.0822
200	.0384	200	.0438	200	.0493	200	.0548
100	.0192	100	.0219	100	.0247	100	.0274
90	.0173	90	.0197	90	.0222	90	.0247
80	.0153	80	.0175	80	.0197	80	.0219
70	.0134	70	.0153	70	.0173	70	.0192
60	.0115	60	.0132	60	.0148	60	.0164
50	.0096	50	.0110	50	.0123	50	.0137
40	.0077	40	.0088	40	.0099	40	.0110
30	.0058	30	.0066	30	.0074	30	.0082
20	.0038	20	.0044	20	.0049	20	.0066
10	.0019	10	.0022	10	.0025	10	.0027
9	.0017	9	.0020	9	.0022	9	.0025
8	.0015	8	.0018	8	.0020	8	.0022
7	.0013	7	.0015	7	.0017	7	.0019
6	.0012	6	.0013	6	.0015	6	.0016
5	.0010	5	.0011	5	.0012	5	.0014
4	.0008	4	.0009	4	.0010	4	.0011
3	.0006	3	.0007	3	.0007	3	.0008
2	.0004	2	.0004	2	.0005	2	.0005
1	.0002	1	.0002	1	.0002	1	.0003



*The Use of the preceding Tables.*

When the Interest of any Sum of Money is required for any Number of Days, multiply the Principal Sum by the Number of Days; and the Interest of that Product for one Day answers the Question.

For, the Interest of one Pound for one hundred Days, is equal to the Interest of one hundred Pounds for one Day.

*Example.*

*What is the Interest of 265 l. for 438 Days, at 6 l. per Cent. per Ann.?*

265 l. multiplied by 438 (the Number of Days) the Product will be 116070 l. the Interest of which Sum take out of the Table of 6 l. per Cent. thus;

The Interest for one Day of 100000 is 16.4384  
10000 is 1.6438  
6000 is .9863  
70 is .0115

Principal 116070 Int. 19.0800

Answer 19 l. 1 s. 7½ d.

And thus, by these Tables, the Interest of any Sum of Money, for any Time, and at any Rate of Interest, from 3 l. to 10 l. per Cent. per Ann. is readily found.

For the more easy finding the Number of Days, from any one Time given, to any other, the following Table is made.

*The Number of Days from any Day in one Month, to the same Day in any other Month.*

From	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Octob.	Nov.	Dec.
	Feb. 31	Mar. 28	Apr. 31	May 30	June 31	July 30	Aug. 31	Sept. 31	Oct. 30	Nov. 31	Dec. 30	Jan. 31
	Mar. 59	Apr. 59	May 61	June 61	July 61	Aug. 61	Sept. 62	Oct. 61	Nov. 61	Dec. 61	Jan. 61	Feb. 62
	Apr. 90	May 89	June 92	July 91	Aug. 92	Sept. 92	Oct. 92	Nov. 92	Dec. 91	Jan. 92	Feb. 92	Mar. 90
	May 120	June 120	July 122	Aug. 122	Sept. 123	Oct. 122	Nov. 123	Dec. 122	Jan. 122	Feb. 123	Mar. 120	Apr. 121
	June 151	July 150	Aug. 153	Sept. 153	Oct. 153	Nov. 153	Dec. 153	Jan. 153	Feb. 153	Mar. 151	Apr. 151	May 151
To	July 181	Aug. 181	Sept. 184	Oct. 183	Nov. 184	Dec. 183	Jan. 184	Feb. 184	Mar. 181	Apr. 182	May 181	June 182
	Aug. 212	Sept. 212	Oct. 213	Nov. 214	Dec. 214	Jan. 214	Feb. 215	Mar. 212	Apr. 212	May 212	June 212	July 212
	Sept. 243	Oct. 242	Nov. 245	Dec. 244	Jan. 245	Feb. 245	Mar. 243	Apr. 243	May 242	June 243	July 242	Aug. 243
	Oct. 273	Nov. 273	Dec. 275	Jan. 275	Feb. 276	Mar. 273	Apr. 274	May 273	June 273	July 273	Aug. 273	Sept. 274
	Nov. 304	Dec. 303	Jan. 306	Feb. 306	Mar. 304	Apr. 304	May 304	June 304	July 303	Aug. 304	Sept. 304	Oct. 304
	Dec. 334	Jan. 334	Feb. 337	Mar. 334	Apr. 335	May 334	June 335	July 334	Aug. 334	Sept. 335	Oct. 334	Nov. 335
	Jan. 365	Feb. 365	Mar. 365	Apr. 365	May 365	June 365	July 365	Aug. 365	Sept. 365	Oct. 365	Nov. 365	Dec. 365

This Table shews the Number of Days, from any Day in any one Month, to the same Day in any other Month; as from the 1st, 5th, 10th, or 20th of May, to the 1st, 5th, 10th, or 20th of November, is 184 Days: Which is thus known.

I find May at the Head of one of the Columns; and looking down that Column, I find November, and even with it 184.

But if the Question is from the 5th of May to the 10th of November, I must add 5; and the Number of Days will be 189. On the contrary, if it be demanded from the 10th of May to the 5th of November, 5 must be subtracted, and the Number will be 179. And thus any Number of Days, not exceeding a Year, are found by Inspection.

If the Time exceed a Year, as from the 10th of May 1706, to the 10th of November 1707, add 365 to the Number found in the Table, and the Answer will be 549 Days.

And as you may thus very easily, and accurately enough, solve all Questions and Cases of Simple Interest; so he next shews how to find the Discount of any Sum of Money for any Time, and at any Rate of Interest, thus:

1. To find the annual Discount of one Pound, at 1 l. per Cent. divide .01 by 1.01. If at 2 per Cent.

divide .02 by 1.02. At 3 per Cent. divide .03 by 1.03, &c. and the Quotients will be the several Discounts required.

Thus the Discount of one Pound for one Year at

1	per Cent.	.009900990099
2	—	.019607843137
3	—	.029126213592
4	—	.038461538462
5	—	.047619047619
6	—	.056603773585
7	—	.065420560748
8	—	.074074074074
9	—	.082568807339
10	—	.090909090909

And then the Discount of 1 l. being multiplied by any Principal Sum, the Product will be the Annual Discount of that Principal.

*Example.*

*What is the Discount of 100 l. at 6 l. per Cent. per Annum?*

.05660, &c. being the Discount of 1 l. for one Year, at the Rate of 6 per Cent. as above; that multi-



multiplied by 100*l.* will produce 5.660377, &c. Which Decimal being reduced, gives us 5*l.* 13*s.* 2½*d.* and no more: And therefore that is to be look'd upon as the true Discount of 100*l.* at 6*l.* per Cent. for one Year.

And yet nothing is more common, than to allow 6*l.* for the Discount of 100*l.* for a Year, at 6*l.* per Cent. But he that doth so, certainly wrongs himself: For he ought to receive so much Money as, at 6*l.* per Cent. Interest, will amount to 100*l.* in one Year, which less than 94*l.* 6*s.* 9½*d.* will not do.

The several Discounts of 1*l.* for one Year (as above) and at the aforefaid Rates, being divided by 365, will give the Discounts for one Day, at the same Rates: *Viz.*

The Discount for one Day at

1 <i>l.</i> per Cent.	.000027126000
2 ———	.000053720118
3 ———	.000079797845
4 ———	.000105374078
5 ———	.000130463144
6 ———	.000155078832
7 ———	.000179234413
8 ———	.000202942669
9 ———	.000226215911
10 ———	.000249066002

And when thus the Discount of *one Pound* for *one Day*, and at any *Rate*, is found; if you multiply that by 2, 3, 4, 5, 6, &c. it will give the Discount of any Sum of Money whatsoever at the same Rate.

Examples at 3 per Cent.

The Discount for one Day of

1 <i>l.</i> - is —	.000079797845
2 — — —	.000159595691
3 — — —	.000239393536
4 — — —	.000319191382
5 — — —	.000398989227
6 — — —	.000478787073
7 — — —	.000558584918
8 — — —	.000638382764
9 — — —	.000718180609
10 — — —	.000797978455
100 — — —	.007979784546
1000 — — —	.079797845458
	&c.

And after this manner the following Tables of Discount are framed.

DISCOUNT



# DISCOUNT for One Day, at 3, 4, 5, and 6 Pound per Cent. per Annum.

At 3 l. per Cent. per An.		At 4 l. per Cent. per An.		At 5 l. per Cent. per An.		At 6 l. per Cent. per An.	
Principal.	Discount.	Principal.	Discount.	Principal.	Discount.	Principal.	Discount.
10000000	797.9785	10000000	1053.7408	10000000	1304.6314	10000000	1550.7883
9000000	718.1806	9000000	948.3667	9000000	1174.1683	9000000	1395.7095
8000000	638.3828	8000000	842.9926	8000000	1043.7052	8000000	1240.6307
7000000	558.5849	7000000	737.6185	7000000	913.2420	7000000	1085.5518
6000000	478.7871	6000000	632.2445	6000000	782.7789	6000000	930.4730
5000000	398.9892	5000000	526.8704	5000000	652.3157	5000000	775.3942
4000000	319.1914	4000000	421.4963	4000000	521.8526	4000000	620.3153
3000000	239.3935	3000000	316.1222	3000000	391.3894	3000000	465.2365
2000000	159.5957	2000000	210.7482	2000000	260.9263	2000000	310.1577
1000000	79.7978	1000000	105.3741	1000000	130.4631	1000000	155.0788
900000	71.8181	900000	94.8367	900000	117.4168	900000	139.5709
800000	63.8383	800000	84.2993	800000	104.3705	800000	124.0631
700000	55.8585	700000	73.7619	700000	91.3242	700000	108.5552
600000	47.8787	600000	63.2244	600000	78.2779	600000	93.0473
500000	39.8989	500000	52.6870	500000	65.2316	500000	77.5394
400000	31.9191	400000	42.1496	400000	52.1853	400000	62.0315
300000	23.9394	300000	31.6122	300000	39.1389	300000	46.5236
200000	15.9596	200000	21.0748	200000	26.0926	200000	31.0158
100000	7.9798	100000	10.5374	100000	13.0463	100000	15.5079
90000	7.1818	90000	9.4837	90000	11.7417	90000	13.9571
80000	6.3838	80000	8.4229	80000	10.4371	80000	12.4063
70000	5.5858	70000	7.3762	70000	9.1324	70000	10.8555
60000	4.7879	60000	6.3224	60000	7.8278	60000	9.3047
50000	3.9899	50000	5.2687	50000	6.5232	50000	7.7539
40000	3.1919	40000	4.2150	40000	5.2185	40000	6.2032
30000	2.3939	30000	3.1612	30000	3.9139	30000	4.6524
20000	1.5960	20000	2.1075	20000	2.6093	20000	3.1016
10000	.7980	10000	1.0537	10000	1.3046	10000	1.5508
9000	.7182	9000	.9484	9000	1.1742	9000	1.3957
8000	.6384	8000	.8430	8000	1.0437	8000	1.2406
7000	.5586	7000	.7376	7000	.9132	7000	1.0856
6000	.4788	6000	.6322	6000	.7828	6000	.9305
5000	.3990	5000	.5269	5000	.6523	5000	.7754
4000	.3192	4000	.4215	4000	.5219	4000	.6203
3000	.2394	3000	.3161	3000	.3914	3000	.4652
2000	.1596	2000	.2107	2000	.2609	2000	.3102
1000	.0798	1000	.1054	1000	.1305	1000	.1551
900	.0718	900	.0948	900	.1174	900	.1396
800	.0638	800	.0843	800	.1044	800	.1241
700	.0559	700	.0738	700	.0913	700	.1086
600	.0479	600	.0632	600	.0783	600	.0930
500	.0399	500	.0527	500	.0652	500	.0775
400	.0319	400	.0421	400	.0522	400	.0620
300	.0239	300	.0316	300	.0391	300	.0465
200	.0160	200	.0211	200	.0261	200	.0310
100	.0080	100	.0105	100	.0130	100	.0155
90	.0072	90	.0095	90	.0117	90	.0140
80	.0064	80	.0084	80	.0104	80	.0124
70	.0056	70	.0074	70	.0091	70	.0109
60	.0048	60	.0063	60	.0078	60	.0093
50	.0040	50	.0053	50	.0065	50	.0078
40	.0032	40	.0042	40	.0052	40	.0062
30	.0024	30	.0032	30	.0039	30	.0047
20	.0016	20	.0021	20	.0026	20	.0031
10	.0008	10	.0011	10	.0013	10	.0016
9	.0007	9	.0009	9	.0012	9	.0014
8	.0006	8	.0008	8	.0010	8	.0012
7	.0006	7	.0007	7	.0009	7	.0011
6	.0005	6	.0006	6	.0008	6	.0009
5	.0004	5	.0005	5	.0007	5	.0008
4	.0003	4	.0004	4	.0005	4	.0006
3	.0002	3	.0003	3	.0004	3	.0005
2	.0002	2	.0002	2	.0003	2	.0003
1	.0001	1	.0001	1	.0001	1	.0002



DISCOUNT for One Day, at 7, 8, 9, and 10 per Cent.  
per Annum.

At 7 l. per Cent. per An.		At 8 l. per Cent. per An.		At 9 l. per Cent. per An.		At 10 l. per Cent. per An.	
Principal.	Discount.	Principal.	Discount.	Principal.	Discount.	Principal.	Discount.
10000000	1792.3441	10000000	2029.4267	10000000	2262.1591	10000000	2490.6600
9000000	1613.1097	9000000	1826.4840	9000000	2035.9432	9000000	2241.5940
8000000	1433.8753	8000000	1623.5414	8000000	1809.7273	8000000	1992.5280
7000000	1254.6409	7000000	1420.5987	7000000	1583.5114	7000000	1743.4620
6000000	1075.4065	6000000	1217.6560	6000000	1357.2955	6000000	1494.3960
5000000	896.1721	5000000	1014.7133	5000000	1131.0796	5000000	1245.3300
4000000	716.9377	4000000	811.7707	4000000	904.8636	4000000	996.2640
3000000	537.7032	3000000	608.8280	3000000	678.6477	3000000	747.1980
2000000	358.4688	2000000	405.8853	2000000	452.4318	2000000	498.1320
1000000	179.2344	1000000	202.9427	1000000	226.2159	1000000	249.0660
900000	161.3110	900000	182.6484	900000	203.5943	900000	224.1594
800000	143.3875	800000	162.3541	800000	180.9727	800000	199.2528
700000	125.4641	700000	142.0599	700000	158.3511	700000	174.3462
600000	107.5406	600000	121.7656	600000	135.7295	600000	149.4396
500000	89.6172	500000	101.4713	500000	113.1080	500000	124.5330
400000	71.6938	400000	81.1771	400000	90.4864	400000	99.6264
300000	53.7703	300000	60.8823	300000	67.8648	300000	74.7198
200000	35.8469	200000	40.5885	200000	45.2432	200000	49.8132
100000	17.9234	100000	20.2943	100000	22.6216	100000	24.9066
90000	16.1311	90000	18.2648	90000	20.3594	90000	22.4159
80000	14.3388	80000	16.2354	80000	18.0973	80000	19.9253
70000	12.5464	70000	14.2060	70000	15.8351	70000	17.4346
60000	10.7541	60000	12.1766	60000	13.5730	60000	14.9440
50000	8.9617	50000	10.1471	50000	11.3108	50000	12.4533
40000	7.1694	40000	8.1177	40000	9.0486	40000	9.9626
30000	5.3770	30000	6.0883	30000	6.7865	30000	7.4720
20000	3.5847	20000	4.0589	20000	4.5243	20000	4.9813
10000	1.7923	10000	2.0294	10000	2.2622	10000	2.4907
9000	1.6131	9000	1.8265	9000	2.0359	9000	2.2416
8000	1.4339	8000	1.6235	8000	1.8097	8000	1.9925
7000	1.2546	7000	1.4206	7000	1.5835	7000	1.7435
6000	1.0754	6000	1.2177	6000	1.3573	6000	1.4944
5000	.8962	5000	1.0147	5000	1.1311	5000	1.2453
4000	.7169	4000	.8118	4000	.9049	4000	.9963
3000	.5377	3000	.6088	3000	.6786	3000	.7472
2000	.3585	2000	.4059	2000	.4524	2000	.4981
1000	.1792	1000	.2029	1000	.2262	1000	.2491
900	.1613	900	.1826	900	.2036	900	.2242
800	.1434	800	.1624	800	.1810	800	.1993
700	.1255	700	.1421	700	.1584	700	.1743
600	.1075	600	.1218	600	.1357	600	.1494
500	.0896	500	.1015	500	.1131	500	.1245
400	.0717	400	.0812	400	.0905	400	.0996
300	.0538	300	.0609	300	.0679	300	.0747
200	.0358	200	.0406	200	.0452	200	.0498
100	.0179	100	.0203	100	.0226	100	.0249
90	.0161	90	.0183	90	.0204	90	.0224
80	.0143	80	.0162	80	.0181	80	.0199
70	.0125	70	.0142	70	.0158	70	.0174
60	.0108	60	.0122	60	.0136	60	.0149
50	.0090	50	.0101	50	.0113	50	.0125
40	.0072	40	.0081	40	.0090	40	.0100
30	.0054	30	.0061	30	.0068	30	.0075
20	.0036	20	.0041	20	.0045	20	.0050
10	.0018	10	.0020	10	.0023	10	.0025
9	.0016	9	.0018	9	.0020	9	.0022
8	.0014	8	.0016	8	.0018	8	.0020
7	.0013	7	.0014	7	.0016	7	.0017
6	.0011	6	.0012	6	.0014	6	.0015
5	.0009	5	.0010	5	.0011	5	.0012
4	.0007	4	.0008	4	.0009	4	.0010
3	.0005	3	.0006	3	.0007	3	.0007
2	.0004	2	.0004	2	.0005	2	.0005
1	.0002	1	.0002	1	.0002	1	.0002



The Use of the preceding Tables.

When the Discount of any Sum of Money is required for any Number of Days, multiply the principal Sum by the Number of Days, and the Discount of that Product for one Day answers the Question.

Example.

What is the Discount of 265 l. for 438 Days, at 6 l. per Cent. per Annum?

265 l. multiplied by 438, (the Number of Days) the Product will be 116070 l.; the Discount of which Sum take out of the Table of 6 l. per Cent. thus:

So 1.					
1.03			1.03		1st Year,
1.0609			1.0609		2d Year,
1.092727	Multiplied by 1.03, the Amount (at 3 l. per Cent.) will be		1.092727	At the End of the	3d Year,
1.125509			1.127509		4th Year,
1.159274			1.15927		5th Year,
1.194052			1.194052		6th Year,
			1.229874		7th Year.

And thus Table the First, following, of the Amount of 1 l. is form'd.

The Present Value of any Sum of Money, payable at the End of any Number of Days, is found by the Reverse of the former Method; viz. by the continued Division of the Principal by 1.03, 1.04, 1.05, 1.06, &c. according as the Rate of Interest, is 3, 4, 5, or 6 l. per Cent.

Thus 1.					
.970874	Divided by 1.03, the present Value (at 3 l. per Cent.) will be		.970874	Payable at the End of the	1st Year,
.942596			.942596		2d Year,
.915142			.915142		3d Year,
.888487			.888487		4th Year,
.862609			.862609		5th Year,
.837484			.837484		6th Year,
			.813092		7th Year.

And thus the Second of the following Tables may be form'd.

The Amount of any Annuity or other yearly Payment, in any Number of Years, at 3 l. per Cent. per Ann. Compound Interest, will be found thus:

Multiply the first yearly Payment by 1.03 (when as in this Case, the Rate of Interest is 3 l. per Cent. otherwise by 1.06, &c. whatever that be) and to the Product add the second Yearly Payment; which Addition will give the Amount in two Years: Multiply that Amount again by 1.03, 1.06, &c. and to the Product add the third yearly Payment; which Addition will give the Amount in three Years, &c.

Example of 1 l. per Ann. at 3 l. per Cent.

First yearly Payment 1 l. the Amount in 1 Year.  
Multiplied by 1.03

Second Yearly Paym.

Multiplied by

1.03

1.

2.03 Amount in 2 Years.

1.03

2.0909

Third Yearly Paym. 1.

3.0909 Amount in 3 Years,  
Multiplied by 1.03

3.183627

Fourth Yearly Paym. 1.

4.183627 Amount in 4 Years,  
&c.

And thus the Third Table following is constructed.

The present Value of any Annuity, or other Yearly Payment, to continue any Number of Years, is thus found.

Find the present Value of that yearly Sum payable at the End of 1, 2, 3, 4, or 5, &c. Years by Division; as is above directed; the first of which Values will be the present Value of that Annuity, or Yearly Payment for one Year: The first and second of those Values added together, will be the present Value for two Years: The first, second, and third, so added, will give the Value for three Years, &c.

Example

The Discount for one Day of 100000 is 15.5079  
10000 is 1.5508  
6000 is .9305  
70 is .0109

Principal 116070. Dif. 18.0001

Answer 18 l.

And thus by these Tables, the Discount of any Sum of Money, for any Time, and at any Rate, from 3 l. to 10 l. per Cent. per Ann. is found readily.

Compound Interest.

The Amount of any Sum of Money in any Number of Years, at Compound Interest, will be always had by the continued Multiplication of the Principal by 1.03, if the Rate of Interest be 3 l. per Cent.; by 1.04, if 4 l. per Cent.; by 1.06, if the Rate be 6 l. per Cent. &c.



Example of 1 l. per Ann. at 3 l. per Cent.

I find the present Value of 1 l. payable at the End of several Years, to be as here under express'd.

At the End of	1	Year is	.970874
	2		.942596
	3		.915142
	4		.888487
	5		.862609
	6		.837484
	7		.813092, &c.

Then the present Value of 1 l. per Ann. at 3 l. per Cent.

For	1	Year is	.870874	being the	1st Number above,	added together.
	2		1.913470		1, 2,	
	3		.828612		1, 2, and 3,	
	4		3.717099		1, 2, 3, and 4,	
	5		1.579708		1, 2, 3, 4, and 5,	
	6		5.417192		1, 2, 3, 4, 5, and 6,	
	7		6.230284		1, 2, 3, 4, 5, 6, and 7,	

And thus the Fourth Table following is Form'd and Composed.

T A B L E



T A B L E I.

The Amount of One Pound in any Number of Years not exceeding 100, at the several Rates of 3, 4, 5, 6, 7, 8, 9, and 10 l. per Cent. per Ann. Compound Interest.

Yr.	3 per Cent.	4 per Cent.	5 per Cent.	6 per Cent.	7 per Cent.	8 per Cent.	9 per Cent.	10 per Cent.
1	1.030000	1.040000	1.050000	1.060000	1.070000	1.080000	1.090000	1.100000
2	1.060900	1.081600	1.102500	1.123600	1.144900	1.166400	1.188100	1.210000
3	1.092727	1.124864	1.157625	1.191016	1.225043	1.259712	1.295029	1.331000
4	1.125509	1.169859	1.215506	1.262477	1.310796	1.360489	1.411582	1.464100
5	1.159274	1.216653	1.276232	1.338226	1.402552	1.469328	1.538624	1.610510
6	1.194052	1.265319	1.340096	1.418519	1.500730	1.586874	1.677100	1.771561
7	1.229874	1.315932	1.407100	1.503630	1.605781	1.713824	1.828039	1.948717
8	1.266770	1.368569	1.477455	1.593848	1.718186	1.850930	1.992563	2.143589
9	1.304773	1.423312	1.551323	1.689479	1.838459	1.999005	2.171893	2.357948
10	1.343916	1.480244	1.628895	1.790848	1.967151	2.158925	2.367364	2.593742
11	1.384234	1.539454	1.710339	1.898299	2.104852	2.331639	2.580426	2.853117
12	1.425761	1.601032	1.795856	2.012196	2.252192	2.518170	2.812665	3.138428
13	1.468534	1.665074	1.885649	2.132928	2.409845	2.719624	3.065805	3.452271
14	1.512590	1.731676	1.979932	2.260904	2.578534	2.937194	3.341727	3.797498
15	1.557967	1.800944	2.078928	2.396558	2.759032	3.172169	3.642482	4.177248
16	1.604706	1.872981	2.182875	2.540352	2.952164	3.425943	3.970306	4.594973
17	1.652848	1.947900	2.292018	2.692773	3.158815	3.700018	4.327633	5.054470
18	1.702433	2.025817	2.406619	2.854339	3.379932	3.996019	4.717120	5.559917
19	1.753506	2.106849	2.526950	3.025600	3.616523	4.315701	5.141661	6.115909
20	1.806111	2.191123	2.653298	3.207135	3.869684	4.660957	5.604411	6.727500
21	1.860295	2.278768	2.785963	3.399564	4.140562	5.033834	6.108808	7.400250
22	1.916103	2.369919	2.925261	3.603537	4.430402	5.436540	6.658600	8.140275
23	1.973587	2.464716	3.071524	3.819750	4.740530	5.871464	7.257874	8.954302
24	2.032794	2.563304	3.225100	4.048935	5.072367	6.341181	7.911083	9.849733
25	2.093778	2.665836	3.386355	4.291871	5.427433	6.848475	8.623081	10.834706
26	2.156591	2.772470	3.555673	4.549383	5.807353	7.396353	9.399158	11.918177
27	2.221289	2.883369	3.733456	4.822346	6.213868	7.988001	10.245082	13.109994
28	2.287928	2.998703	3.920129	5.111687	6.648838	8.627106	11.167139	14.420994
29	2.356566	3.118651	4.116136	5.418388	7.114257	9.317275	12.172182	15.863093
30	2.427262	3.243398	4.321942	5.743491	7.612255	10.062657	13.267678	17.449402
31	2.500080	3.373133	4.538039	6.088101	8.145113	10.867669	14.461769	19.194342
32	2.575083	3.508059	4.764941	6.453387	8.715271	11.737083	15.763329	21.113777
33	2.652335	3.648381	5.003139	6.840590	9.325340	12.676050	17.182028	23.225155
34	2.731905	3.794316	5.253343	7.251025	9.978114	13.690134	18.728411	25.547671
35	2.813862	3.946089	5.516015	7.686087	10.676581	14.785344	20.413968	28.102438
36	2.898278	4.103933	5.791816	8.147252	11.423942	15.968172	22.251225	30.912681
37	2.985227	4.268090	6.081407	8.636037	12.223618	17.245626	24.253835	34.003949
38	3.074783	4.438813	6.385477	9.154252	13.079271	18.625276	26.436630	37.404344
39	3.167027	4.616366	6.704751	9.703507	13.994820	20.115298	28.815982	41.144779
40	3.262038	4.801021	7.039989	10.285718	14.974458	21.724521	31.409420	45.259257
41	3.359899	4.993061	7.391988	10.902861	16.022670	23.462483	34.236268	49.785182
42	3.460696	5.192784	7.761588	11.557033	17.144257	25.339482	37.317532	54.763701
43	3.564517	5.400495	8.149667	12.250455	18.344355	27.366640	40.676110	60.240071
44	3.671452	5.616515	8.557150	12.985482	19.628460	29.555972	44.336960	66.264078
45	3.781596	5.841176	8.985003	13.764611	21.002452	31.920449	48.327286	72.890486
46	3.895044	6.074823	9.434258	14.590487	22.472623	34.474085	52.676742	80.179534
47	4.011895	6.317816	9.905971	15.465917	24.045707	37.232012	57.417649	88.197488
48	4.132252	6.570528	10.401270	16.393872	25.728907	40.210573	62.585237	97.017236
49	4.256219	6.833349	10.921333	17.377304	27.529930	43.427419	68.217908	106.718960



T A B L E I. continued.

Being the Amount of One Pound, in any Number of Years, from 50 to 100, at the several Rates of 3, 4, 5, 6, 7, 8, 9, and 10 *l.* per Cent. per Ann. Compound Interest.

Ye.	3 per Cent.	4 per Cent.	5 per Cent.	6 per Cent.	7 per Cent.	8 per Cent.	9 per Cent.	10 per Cent.
50	4.383906	7.106983	11.467400	18.420154	29.457025	46.901612	74.357520	117.300806
51	4.515423	7.390951	12.040770	19.525363	31.519017	50.653741	81.049697	129.129942
52	4.650386	7.686589	12.642808	20.696885	33.725348	54.706041	88.344170	142.042936
53	4.790412	7.994052	13.274949	21.938698	36.086122	59.082524	96.295145	156.247229
54	4.934125	8.313814	13.938696	23.255020	38.612151	63.809126	104.961708	171.871952
55	5.082149	8.646367	14.635631	24.650322	41.315001	68.913856	114.408262	189.059147
56	5.234613	8.992222	15.367412	26.129341	44.207052	74.426964	124.705005	207.965062
57	5.391651	9.351910	16.135783	27.697101	47.301545	80.381182	135.928456	228.761568
58	5.553401	9.725987	16.942572	29.358927	50.612653	86.811611	148.162017	251.637725
59	5.720003	10.115026	17.789701	31.120463	54.155539	93.756540	161.496598	276.801489
60	5.891603	10.519627	18.679186	32.987691	57.946427	101.257064	176.031292	304.481648
61	6.068351	10.940413	19.613145	34.966952	62.002677	109.357629	191.874108	334.929871
62	6.250402	11.378029	20.593802	37.064969	66.342864	118.106239	209.142778	368.422794
63	6.437914	11.833150	21.623493	39.288868	70.986865	127.554738	227.965628	405.265073
64	6.631051	12.306476	22.704667	41.646200	75.955945	137.759117	248.482535	445.791580
65	6.829982	12.798735	23.839901	44.144972	81.272861	148.779846	270.845963	490.370728
66	7.034882	13.310685	25.031896	46.793670	86.961962	160.682234	295.222099	539.407812
67	7.245929	13.843112	26.283490	49.601290	93.049299	173.536813	321.792088	593.348593
68	7.463307	14.396836	27.597665	52.577368	99.562750	187.419758	350.753376	652.683453
69	7.687206	14.972710	28.977548	55.732010	106.532142	202.413338	382.321180	717.951798
70	7.917822	15.571618	30.426426	59.075930	113.989392	218.606406	416.730086	789.746978
71	8.155357	16.194483	31.947747	62.620486	121.968650	236.094918	454.235794	868.721675
72	8.400017	16.842262	33.545134	66.377715	130.506455	254.982511	495.117016	955.593843
73	8.652081	17.515953	35.222391	70.360378	139.641907	275.381112	539.677547	1051.153227
74	8.911578	18.216591	36.983510	74.582001	149.416840	297.411601	588.248526	1156.268550
75	9.178926	18.945255	38.832686	79.056921	159.876019	321.204529	641.190894	1271.895405
76	9.454293	19.703065	40.774320	83.800336	171.067341	346.900892	698.898074	1399.084945
77	9.737922	20.491187	42.813036	88.828356	183.042054	374.652963	761.798901	1538.993440
78	10.030060	21.310835	44.953688	94.158058	195.854998	404.625200	830.360802	1692.892784
79	10.330962	22.163269	47.201372	98.807541	209.564848	436.995216	905.093274	1862.182062
80	10.640891	23.049799	49.561441	105.795993	224.234388	471.954834	986.551660	2048.400269
81	10.960117	23.971791	52.039513	112.143753	239.930795	509.711220	1075.341319	2253.240295
82	11.288921	24.930663	54.641489	118.872378	256.725950	550.488118	1172.122037	2478.564325
83	11.627588	25.927889	57.373563	126.004721	274.696767	594.527167	1277.613021	2726.420757
84	11.976416	26.965005	60.242241	133.565004	293.925540	642.089341	1392.598193	2999.062833
85	12.335709	28.043605	63.254353	141.578904	314.500328	693.456488	1517.932030	3298.969117
86	12.705780	29.165349	66.417071	150.073639	336.515351	748.933007	1654.545913	3628.866028
87	13.086953	30.331963	69.737925	159.078057	360.071426	808.847648	1803.455045	3991.752631
88	13.479562	31.545242	73.224821	168.622741	385.276426	873.555459	1965.765999	4390.927894
89	13.883949	32.807051	76.886062	178.740105	412.245776	943.439896	2142.684939	4830.020684
90	14.300467	34.119333	80.730365	189.464511	441.102980	1018.915088	2335.526583	5313.022752
91	14.729481	35.484107	84.766883	200.832382	471.980188	1100.428295	2545.723976	5844.325027
92	15.171366	36.903471	89.005227	212.882325	505.018802	1188.462558	2774.839134	6428.757530
93	15.626507	38.379610	93.455489	225.655264	540.370118	1283.539563	3024.574656	7071.633283
94	16.095302	39.914794	98.128263	239.194580	578.196026	1386.222728	3296.786375	7778.796611
95	16.578161	41.511386	103.034676	253.546255	618.669748	1497.120546	3593.497148	8556.676272
96	17.075506	43.171841	108.186410	268.759030	661.976630	1616.890190	3916.911892	9412.343899
97	17.587771	44.898715	113.595731	284.884572	708.314994	1746.241405	4269.433962	10353.578289
98	18.115404	46.694664	119.275517	301.977646	757.897044	1885.940718	4653.683018	11388.936118
99	18.658866	48.562450	125.239293	320.096305	810.949837	2036.815975	5072.514490	12527.829730
100	19.218632	50.504948	131.501258	339.302084	867.716325	2109.761253	5529.040791	13780.612703



T A B L E II.

The Present Value of One Pound, payable at the End of any Number of Years not exceeding 100, Discounting at the several Rates of 3, 4, 5, 6, 7, 8, 9, and 10 *l. per Cent. per Ann.* Compound Interest.

Ye.	3 per Cent.	4 per Cent.	5 per Cent.	6 per Cent.	7 per Cent.	8 per Cent.	9 per Cent.	10 per Cent.
1	.970874	.961539	.952381	.943396	.934579	.925926	.917431	.909091
2	.942596	.924556	.907029	.889997	.873439	.857339	.841680	.826446
3	.915142	.888996	.863838	.839619	.816298	.793832	.772184	.751315
4	.888487	.854804	.822702	.792094	.762895	.735030	.708425	.683013
5	.862609	.821927	.783526	.747258	.712986	.680583	.649931	.620921
6	.837484	.790315	.746216	.704960	.666342	.630170	.596267	.564474
7	.813092	.759918	.710682	.665057	.622750	.583491	.547034	.513158
8	.789409	.730690	.676839	.627412	.582009	.540269	.501866	.466507
9	.766417	.702587	.644609	.591898	.543934	.500249	.460428	.424098
10	.744094	.675564	.613913	.558395	.508349	.463194	.422411	.385543
11	.722411	.649581	.584679	.526787	.475093	.428883	.387533	.350494
12	.701380	.624597	.556837	.496969	.444012	.397114	.355535	.318631
13	.680951	.600574	.530321	.468839	.414965	.367698	.326179	.289664
14	.661118	.577475	.505068	.442301	.387817	.340461	.299246	.263331
15	.641862	.555265	.481017	.417265	.362446	.315242	.274538	.239392
16	.623167	.533908	.458112	.393646	.338735	.291891	.251870	.217629
17	.605017	.513373	.436297	.371314	.316574	.270269	.231073	.197845
18	.587395	.493628	.415521	.350344	.295864	.250249	.211994	.179859
19	.570286	.474643	.395734	.330513	.276508	.231712	.194490	.163508
20	.553676	.456387	.376890	.311805	.258419	.214548	.178431	.148644
21	.537549	.438834	.358942	.294155	.241513	.198657	.163698	.135131
22	.521892	.421955	.341850	.277505	.225713	.183941	.150182	.122846
23	.506692	.405726	.325571	.261797	.210947	.170315	.137781	.111678
24	.491934	.390121	.310068	.246979	.197147	.157699	.126405	.101526
25	.477606	.375717	.295303	.232999	.184249	.146018	.115968	.092296
26	.463695	.360689	.281241	.219810	.172196	.135202	.106392	.083905
27	.450189	.346816	.267848	.207368	.160930	.125187	.097607	.076278
28	.437077	.333477	.255094	.195630	.150402	.115914	.089548	.069343
29	.424346	.320651	.242946	.184557	.140563	.107328	.082155	.063039
30	.411987	.308319	.231377	.174110	.131367	.099377	.075371	.057309
31	.399987	.296460	.220359	.164255	.122773	.092016	.069148	.052099
32	.388337	.285052	.209866	.154957	.114741	.085200	.063438	.047362
33	.377026	.274094	.199873	.146186	.107235	.078889	.058200	.043057
34	.366045	.263552	.190355	.137012	.100219	.073045	.054395	.039143
35	.355383	.253416	.181290	.130105	.093663	.067635	.048986	.035584
36	.345032	.243669	.172657	.122741	.087535	.062625	.044941	.032349
37	.334983	.234297	.164436	.115793	.081809	.057986	.041231	.029408
38	.325226	.225295	.156605	.109238	.076457	.053690	.037826	.026735
39	.315754	.216621	.149148	.103056	.071455	.049713	.034703	.024304
40	.306557	.208289	.142046	.097222	.066780	.046031	.031838	.022095
41	.297658	.200278	.135282	.091719	.062412	.042621	.029209	.020086
42	.288959	.192575	.128840	.086527	.058329	.039464	.026797	.018260
43	.280543	.185168	.122704	.081630	.054513	.036541	.024584	.016600
44	.272372	.178046	.116861	.077009	.050946	.033834	.022555	.015091
45	.264439	.171198	.111297	.072650	.047614	.031328	.020692	.013719
46	.256737	.164614	.105997	.068538	.044499	.029007	.018984	.012472
47	.249259	.158283	.100949	.064658	.041587	.026859	.017416	.011338
48	.241999	.152195	.096142	.060998	.038867	.024869	.015978	.010307
49	.234950	.146341	.091564	.057546	.036324	.023027	.014659	.009370
50	.228107	.140713	.087204	.054288	.033948	.021321	.013449	.008519



T A B L E II. continued.

Being the present Value of One Pound, payable at the End of any Number of Years from 51 to 100, discounting at the several Rates of 3, 4, 5, 6, 7, 8, 9, and 10 *l. per Cent. per Ann.* Compound Interest.

Ye.	3 per Cent.	4 per Cent.	5 per Cent.	6 per Cent.	7 per Cent.	8 per Cent.	9 per Cent.	10 per Cent.
51	.221463	.135301	.083051	.051215	.031727	.019742	.012338	.007744
52	.215013	.130097	.079096	.048316	.029651	.018280	.011319	.007040
53	.208750	.125093	.075330	.045582	.027711	.016925	.010385	.006400
54	.202670	.120282	.071743	.043001	.025899	.015672	.009527	.005818
55	.196767	.115656	.068326	.040567	.024204	.014511	.008741	.005289
56	.191036	.111207	.065073	.038271	.022621	.013436	.008019	.004808
57	.185472	.106930	.061974	.036105	.021141	.012441	.007357	.004371
58	.180070	.102817	.059023	.034061	.019758	.011519	.006749	.003974
59	.174825	.098863	.056212	.032133	.018465	.010666	.006192	.003613
60	.169733	.095060	.053536	.030314	.017257	.009876	.005681	.003284
61	.164789	.091404	.050986	.028598	.016128	.009144	.005212	.002986
62	.159990	.087889	.048558	.026980	.015073	.008467	.004781	.002714
63	.155330	.084508	.046246	.025453	.014087	.007840	.004387	.002468
64	.150806	.081258	.044044	.024012	.013166	.007259	.004024	.002243
65	.146413	.078133	.041946	.022653	.012304	.006721	.003692	.002039
66	.142149	.075128	.039949	.021370	.011497	.006223	.003387	.001854
67	.138009	.072238	.038047	.020161	.010747	.005762	.003108	.001685
68	.133989	.069460	.036235	.019020	.010044	.005336	.002851	.001532
69	.130086	.066788	.034509	.017943	.009387	.004940	.002616	.001393
70	.126297	.064219	.032866	.016927	.008773	.004574	.002400	.001266
71	.122619	.061749	.031301	.015969	.008199	.004236	.002202	.001151
72	.119047	.059374	.029811	.015065	.007662	.003922	.002020	.001046
73	.115580	.057091	.028391	.014213	.007161	.003631	.001853	.000951
74	.112214	.054895	.027039	.013408	.006693	.003362	.001700	.000865
75	.108945	.052784	.025752	.012649	.006255	.003113	.001560	.000786
76	.105772	.050754	.024525	.011933	.005846	.002883	.001431	.000715
77	.102691	.048801	.023357	.011258	.005463	.002669	.001313	.000649
78	.099700	.046924	.022245	.010620	.005106	.002471	.001204	.000591
79	.096796	.045120	.021186	.010019	.004772	.002288	.001105	.000537
80	.093997	.043384	.020177	.009452	.004460	.002119	.001014	.000488
81	.091240	.041716	.019216	.008917	.004168	.001962	.000930	.000444
82	.088582	.040111	.018301	.008412	.003895	.001817	.000853	.000403
83	.086002	.038569	.017430	.007936	.003640	.001682	.000783	.000367
84	.083497	.037085	.016600	.007487	.003402	.001557	.000718	.000333
85	.081065	.035659	.015809	.007063	.003180	.001442	.000659	.000303
86	.078704	.034287	.015056	.006663	.002972	.001335	.000604	.000276
87	.076412	.032969	.014339	.006286	.002777	.001236	.000554	.000251
88	.074186	.031701	.013657	.005930	.002596	.001145	.000509	.000228
89	.072026	.030481	.013006	.005595	.002425	.001060	.000467	.000207
90	.069928	.029309	.012387	.005278	.002267	.000981	.000428	.000188
91	.067891	.028182	.011797	.004979	.002119	.000909	.000393	.000171
92	.065914	.027098	.011235	.004697	.001980	.000841	.000360	.000156
93	.063994	.026056	.010700	.004432	.001851	.000779	.000331	.000141
94	.062130	.025053	.010191	.004181	.001730	.000721	.000303	.000129
95	.060320	.024090	.009705	.003944	.001616	.000668	.000278	.000117
96	.058563	.023163	.009243	.003721	.001511	.000618	.000255	.000106
97	.056858	.022272	.008803	.003510	.001412	.000573	.000234	.000097
98	.055202	.021416	.008384	.003312	.001319	.000530	.000215	.000088
99	.053594	.020592	.007985	.003124	.001233	.000491	.000197	.000080
100	.052033	.019800	.007604	.002947	.001152	.000455	.000181	.000073



T A B L E III.

The Amount of One Pound in any Number of Years not exceeding 100, at the several Rates of 3, 4, 5, 6, 7, 8, 9, and 10 *l. per Cent. per Ann.* Compound Interest.

Ye.	3 per Cent.	4 per Cent.	5 per Cent.	6 per Cent.	7 per Cent.	8 per Cent.	9 per Cent.	10 per Cent.
1	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
2	2.030000	2.040000	2.050000	2.060000	2.070000	2.080000	2.090000	2.100000
3	3.090968	3.121606	3.152500	3.183600	3.214900	3.246400	3.278100	3.310000
4	4.183627	4.246464	4.310125	4.374616	4.439943	4.506112	4.573129	4.641000
5	5.309136	5.416323	5.525631	5.637093	5.750739	5.866601	5.984711	6.105100
6	6.468410	6.632975	6.801913	6.975319	7.153291	7.335929	7.523335	7.715610
7	7.662462	7.898294	8.142003	8.393838	8.654021	8.922803	9.200435	9.487171
8	8.892336	9.214226	9.549109	9.897468	10.259803	10.636628	11.028474	11.435888
9	10.159106	10.532795	11.026564	11.491316	11.977989	12.487558	13.021036	13.579477
10	11.463879	12.006107	12.577893	13.180795	13.816448	14.486562	15.192930	15.937425
11	12.807796	13.486351	14.206787	14.971643	15.783599	16.645487	17.560293	18.531167
12	14.192030	15.025805	15.917127	16.869941	17.888451	18.977126	20.140720	21.384284
13	15.617790	16.626838	17.712983	18.882138	20.140643	21.495297	22.953385	24.522712
14	17.086324	18.291911	19.598632	21.015066	22.550483	24.214920	26.019189	27.974983
15	18.598914	20.023588	21.578564	23.275970	25.129022	27.152114	29.360916	31.772482
16	20.156881	21.824531	23.657492	25.672528	27.888054	30.324283	33.003399	35.949730
17	21.761588	23.697512	25.840366	28.212880	30.840217	33.750226	36.973704	40.544703
18	23.414435	25.645413	28.132385	30.905653	33.999033	37.450244	41.301338	45.599173
19	25.116868	27.671229	30.539004	33.759992	37.378965	41.446263	46.018458	51.159090
20	26.870374	29.778079	33.065954	36.785591	40.995492	45.761964	51.160119	57.274999
21	28.676486	31.969202	35.719252	39.992727	44.865177	50.422921	56.764530	64.002499
22	30.536780	34.247970	38.505214	43.392290	49.005739	55.456755	62.873338	71.402749
23	32.452884	36.617889	41.430475	46.995828	53.436141	60.892296	69.531938	79.543024
24	34.426470	39.082604	44.501999	50.815577	58.176671	66.764759	76.789813	88.497327
25	36.459264	41.645908	47.727099	54.864512	63.249038	73.105940	84.700896	98.347059
26	38.553042	44.311745	51.113454	59.156383	68.676470	79.954415	98.323977	109.181765
27	40.709633	47.084214	54.669126	63.705766	74.483823	87.350768	102.723134	121.099942
28	42.930922	49.967583	58.402583	68.528112	80.697691	95.338830	112.968216	134.209936
29	45.218850	52.966286	62.322712	73.639798	87.346529	103.965936	124.135356	148.630930
30	47.575416	56.084938	66.438848	79.058186	94.460786	113.283211	136.307538	164.494023
31	50.002678	59.328335	70.760790	84.801677	102.073041	123.345868	149.575216	181.943425
32	52.502759	62.701469	75.298829	90.889778	110.218154	134.213537	164.036986	201.137773
33	55.077841	66.209527	80.063771	97.343165	118.933425	145.950620	179.800315	222.251550
34	57.730177	69.857909	85.066959	104.183755	128.258765	158.626670	196.982343	245.476705
35	60.462082	73.652225	90.320307	111.434780	138.236878	172.316804	215.710754	271.024376
36	63.275944	77.598314	95.839323	119.120867	148.913460	187.102148	236.124722	299.126813
37	66.174223	81.702246	101.628139	127.268119	160.337402	203.070320	258.375947	330.039495
38	69.159449	85.970336	107.709546	135.904206	172.561020	220.315945	282.629782	364.043444
39	72.234233	90.409150	114.095023	145.058458	185.640292	238.941221	309.066463	401.447789
40	75.401260	95.025516	120.799774	154.761966	199.635112	259.056519	337.882444	442.522568
41	78.663298	99.826536	127.839763	165.047684	214.609570	280.781040	369.291864	487.851824
42	82.023197	104.819598	135.231751	175.950545	230.632240	304.243523	403.528132	537.637007
43	85.483892	110.012382	142.993339	187.507577	247.776496	329.583005	440.845664	592.400707
44	89.048409	115.412877	151.143006	199.758032	266.120851	356.949645	481.421775	652.640778
45	92.719861	121.029392	159.700156	212.743514	285.749311	386.505617	525.858735	718.904856
46	96.501457	126.870568	168.685164	226.508125	306.751763	418.426066	574.186021	791.795342
47	100.396501	132.945390	178.119422	241.098612	329.224386	452.900152	626.862763	871.974876
48	104.408396	139.263206	188.025393	256.564529	353.270093	490.132164	684.280411	960.172363
49	108.540648	145.833734	198.426663	272.958401	378.998999	530.342737	746.865648	1057.189600
50	112.796867	152.667084	209.347996	290.335905	406.528929	573.770156	815.083557	1163.908560



T A B L E III. continued.

Being the Amount of One Pound, in any Number of Years, not exceeding 100, at the several Rates of 3, 4, 5, 6, 7, 8, 9, and 10 *per Cent. per Ann.* Compound Interest.

Ye.	3 per Cent.	4 per Cent.	5 per Cent.	6 per Cent.	7 per Cent.	8 per Cent.	9 per Cent.	10 per Cent.
51	117.180773	159.773767	220.815395	308.756059	435.985955	620.671768	889.441077	1281.299416
52	121.696197	167.164718	232.856165	328.281422	467.504971	671.325510	970.490774	1410.429357
53	126.347083	174.851306	245.498974	348.978303	501.230319	726.031550	1058.834943	1552.472293
54	131.137495	182.845359	258.773922	370.917006	537.316442	785.114074	1155.130033	1703.719522
55	136.071620	191.159173	272.712618	394.172027	575.928593	848.923200	1260.091796	1880.591474
56	141.153768	199.805540	287.348249	418.822348	617.253594	917.837056	1374.500058	2069.650622
57	146.388381	208.797762	302.715662	444.951689	661.450646	992.264021	1499.205063	2277.615534
58	151.780033	218.149672	318.851445	472.648790	708.752191	1072.645143	1635.133519	2506.377252
59	157.333434	227.875659	335.794017	502.007718	759.364844	1159.456754	1783.295535	2758.014978
60	163.053437	237.990685	353.583718	533.128181	813.520383	1253.213294	1944.792134	3034.816476
61	168.945040	248.510313	372.262904	566.115872	871.466810	1354.470358	2120.823426	3339.298123
62	175.013391	259.450725	391.876049	601.082824	933.469487	1463.827986	2312.697534	3674.227935
63	181.263793	270.828754	412.469851	638.147793	999.812351	1581.934225	2521.840312	4042.650729
64	187.701707	282.661904	434.093344	677.436661	1070.799215	1709.488963	2749.805940	4447.915802
65	194.332758	294.968380	456.789011	719.082861	1146.755161	1847.248080	2998.288475	4893.707382
66	201.162741	307.767116	480.637912	763.227832	1228.028022	1996.027927	3269.134438	5384.078120
67	208.197623	321.077800	505.669807	810.021502	1314.989983	2156.710161	3564.356537	5923.485932
68	215.443552	334.920912	531.953298	859.622792	1408.039282	2330.246974	3886.148625	6516.834526
69	222.906858	349.317749	559.550963	912.200160	1507.602032	2517.666731	4236.902002	7169.517973
70	230.594064	364.290459	588.528511	967.932170	1614.134173	2720.080070	4619.223182	7887.469776
71	238.511886	379.862077	618.954936	1027.008100	1728.123566	2938.686476	5035.953268	8677.216754
72	246.667242	396.056560	650.902683	1089.628586	1850.092216	3174.781394	5490.189062	9545.938429
73	255.067260	412.898823	684.417817	1156.006301	1980.598671	3429.763905	5985.306078	10501.532272
74	263.719277	430.414775	719.670208	1226.366579	2120.240578	3705.145017	6524.983625	11552.685499
75	272.630856	448.631366	756.653718	1300.948680	2269.657418	4002.556619	7113.232151	12708.954049
76	281.809781	467.576621	795.486404	1380.005601	2429.533438	4323.761148	7754.423045	13980.849454
77	291.264075	487.279686	836.260724	1463.805937	2600.600778	4670.662040	8453.321119	15379.934399
78	301.001997	507.770873	879.073761	1552.634293	2783.642833	5045.315003	9215.120019	16918.927839
79	311.032057	529.081703	924.027449	1646.792350	2979.497831	5449.940204	10045.480321	18611.820623
80	321.363019	551.244977	971.228821	1746.599891	3189.062679	5886.935420	10950.574095	20474.002686
81	332.003909	574.294776	1020.750262	1852.395885	3413.297067	6358.890253	11937.125764	22522.402954
82	342.964027	598.266567	1072.829775	1964.539638	3653.227862	6868.601474	13012.467082	24775.643250
83	354.252947	623.197229	1127.471264	2083.412016	3909.953812	7419.089592	14184.589120	27254.207575
84	365.880536	649.125119	1184.844827	2209.416737	4184.650579	8013.616759	15462.202141	29980.628332
85	377.856952	676.090123	1245.087069	2342.981741	4478.576119	8655.706100	16854.800333	32979.691165
86	390.192660	704.133728	1308.341422	2484.560646	4793.076448	9349.162587	18372.732303	36278.660282
87	402.898440	733.299078	1374.758493	2634.634285	5129.591799	10098.095591	20027.278276	39907.526310
88	415.985393	763.631041	1444.496418	2793.712342	5489.663225	10906.943242	21830.733321	43899.278941
89	429.464955	795.176282	1517.721239	2962.335082	5874.939651	11780.498701	23796.499320	48290.006335
90	443.348904	827.983334	1594.607301	3141.075187	6287.185426	12723.938597	25939.184258	53120.227519
91	457.649371	862.102667	1675.337666	3330.539698	6728.288406	13742.853685	28274.710842	58433.250271
92	472.378852	897.586774	1760.104549	3531.372080	7200.268594	14843.281980	30820.434817	64277.575298
93	487.550218	934.490244	1849.109776	3744.254425	7705.287396	16031.744538	33595.273951	70706.322327
94	503.176724	972.869854	1942.565265	3969.909669	8245.657514	17315.284101	36619.848607	77777.966110
95	519.272026	1012.784648	2040.693528	4209.104250	8823.853540	18701.506829	39916.634931	85556.762721
96	535.850187	1054.296034	2143.728205	4462.650504	9442.523288	20198.627376	43510.132130	94113.438993
97	552.925692	1097.467876	2251.914615	4731.409535	10104.499918	21815.517566	47427.044021	103525.782892
98	570.513463	1142.366591	2365.510346	5016.294107	10812.814912	23561.758971	51695.477983	113879.361182
99	588.628867	1189.061254	2484.785863	5318.271753	11570.711950	25447.699689	56350.161002	125268.297300
100	607.287733	1237.623705	2610.025156	5638.368058	12381.661793	27484.515664	61422.675492	137796.127030



T A B L E IV.

The Present Value of One Pound *per Annum*, for any Number of Years to come, not exceeding 100, at the several Rates of 3, 4, 5, 6, 7, 8, 9, and 10 *l. per Cent. per Ann.* Compound Interest.

Ye.	3 per Cent.	4 per Cent.	5 per Cent.	6 per Cent.	7 per Cent.	8 per Cent.	9 per Cent.	10 per Cent.
1	.970874	.961539	.952381	.943396	.934579	.925926	.917431	.909091
2	1.913370	1.886095	1.859410	1.833393	1.808018	1.783265	1.759111	1.735537
3	2.828612	2.775091	2.723248	2.673012	2.624316	2.577097	2.531295	2.486852
4	3.717099	3.629896	3.545950	3.465106	3.387211	3.312127	3.239720	3.169865
5	4.579707	4.451823	4.329477	4.212364	4.100198	3.992710	3.889651	3.790787
6	5.497192	5.242137	5.075612	4.917325	4.766540	4.622880	4.485919	4.355261
7	6.230283	6.002055	5.786374	5.582382	5.389290	5.206371	5.032953	4.868419
8	7.019693	6.732745	6.463213	6.209794	5.971299	5.746640	5.534819	5.334926
9	7.786109	7.435332	7.107822	6.801692	6.515233	6.246889	5.995247	5.759024
10	8.530203	8.110896	7.721735	7.360087	7.023582	6.710082	6.417658	6.144567
11	9.252625	8.760477	8.306415	7.886875	7.498675	7.138965	6.805191	6.495061
12	9.954005	9.385074	8.863252	8.383844	7.942687	7.536079	7.160725	6.813692
13	10.634956	9.985648	9.393573	8.852683	8.357652	7.903777	7.486904	7.103356
14	11.296074	10.563124	9.898641	9.294984	8.745469	8.244238	7.786151	7.366688
15	11.937936	11.118388	10.379658	9.712249	9.107915	8.559480	8.060689	7.606080
16	12.561103	11.652297	10.837770	10.105895	9.446649	8.851370	8.312559	7.823709
17	13.166120	12.165670	11.274067	10.477260	9.763224	9.121639	8.543632	8.021553
18	13.753515	12.659298	11.689587	10.827603	10.059088	9.371888	8.755625	8.201412
19	14.323801	13.133941	12.085321	11.158116	10.335596	9.603601	8.950115	8.364920
20	14.877476	13.590328	12.462211	11.469921	10.594016	9.818149	9.128546	8.513564
21	15.415026	14.029162	12.821153	11.764077	10.835525	10.016805	9.292244	8.648694
22	15.938918	14.451117	13.163003	12.041582	11.061242	10.200745	9.442426	8.771540
23	16.443610	14.856843	13.488574	12.303379	11.272189	10.371061	9.580207	8.883218
24	16.935544	15.246965	13.798642	12.550357	11.469335	10.528760	9.706612	8.984744
25	17.413149	15.622082	14.093945	12.783356	11.653585	10.674778	9.822580	9.077040
26	17.876844	15.982771	14.375186	13.003166	11.825780	10.809980	9.928973	9.160945
27	18.327033	16.329587	14.643034	13.210534	11.986710	10.935167	10.026580	9.237223
28	18.764110	16.663065	14.898128	13.406164	12.137113	11.051081	10.116128	9.306566
29	19.188456	16.983716	15.141074	13.590721	12.277676	11.158408	10.198283	9.369606
30	19.600443	17.292035	15.372452	13.764831	12.409043	11.257785	10.273654	9.426914
31	20.000430	17.588495	15.592811	13.929086	12.531816	11.349802	10.342802	9.479013
32	20.388767	17.873553	15.802677	14.084043	12.646557	11.435002	10.406240	9.526376
33	20.765793	18.147647	16.002550	14.230229	12.753792	11.513891	10.464441	9.569432
34	21.131838	18.411199	16.192905	14.368141	12.854011	11.586936	10.517836	9.608575
35	21.487222	18.664615	16.374195	14.498246	12.947674	11.654570	10.566822	9.644159
36	21.832254	18.908284	16.546852	14.620987	13.035209	11.717195	10.611763	9.676508
37	22.167237	19.142580	16.711288	14.736780	13.117018	11.775181	10.652994	9.705917
38	22.492464	19.367866	16.867893	14.846019	13.193475	11.828871	10.690820	9.732651
39	22.808217	19.584486	17.017041	14.949074	13.264930	11.878585	10.725523	9.756956
40	23.114774	19.792775	17.159087	15.046297	13.331710	11.924615	10.757360	9.779051
41	23.412402	19.993053	17.294369	15.138016	13.394122	11.967237	10.786569	9.799137
42	23.701361	20.185628	17.423208	15.224543	13.452451	12.006701	10.813366	9.817397
43	23.981904	20.370797	17.545913	15.306173	13.506963	12.043242	10.837951	9.833998
44	24.254276	20.548843	17.662774	15.383182	13.557910	12.077076	10.860505	9.849089
45	24.518715	20.720041	17.774070	15.455832	13.605523	12.108404	10.881197	9.862808
46	24.775451	20.884655	17.880067	15.524370	13.650022	12.137411	10.900181	9.875280
47	25.024710	21.042938	17.981016	15.589028	13.691609	12.164269	10.917597	9.886618
48	25.266709	21.195133	18.077158	15.650026	13.730476	12.189139	10.933576	9.896925
49	25.501659	21.341474	18.168722	15.707572	13.766800	12.212165	10.948235	9.906296
50	25.729766	21.482186	18.255926	15.761860	13.800748	12.233487	10.961683	9.914814



T A B L E IV. continued.

Being the Present Value of One Pound *per Annum*, for any Number of Years to come, not exceeding 100, at the several Rates of 3, 4, 5, 6, 7, 8, 9, and 10 *per Cent. per Ann.* Compound Interest.

Ye.	3 per Cent.	4 per Cent.	5 per Cent.	6 per Cent.	7 per Cent.	8 per Cent.	9 per Cent.	10 per Cent.
51	25.951230	21.617487	18.338977	15.813076	13.832475	12.253229	10.974021	9.922558
52	26.166242	21.747584	18.418074	15.861392	13.862126	12.271508	10.985341	9.929599
53	26.374993	21.872677	18.493403	15.906974	13.889838	12.288434	10.995725	9.935999
54	26.577663	21.992958	18.565146	15.949975	13.915736	12.304105	11.005253	9.941817
55	26.774430	22.108614	18.633472	15.990543	13.939941	12.318616	11.013993	9.947106
56	26.965466	22.219821	18.698545	16.028814	13.962561	12.332052	11.022012	9.951915
57	27.150938	22.326751	18.760519	16.064919	13.983702	12.344493	11.029369	9.956286
58	27.331008	22.429568	18.819542	16.098980	14.003460	12.356012	11.036118	9.960260
59	27.505833	22.528431	18.875754	16.131113	14.021926	12.366678	11.042310	9.963873
60	27.675566	22.623491	18.929290	16.161428	14.039185	12.376554	11.047991	9.967157
61	27.840356	22.714896	18.980276	16.190026	14.055311	12.385698	11.053203	9.970143
62	28.000346	22.802784	19.028834	16.217006	14.070384	12.394165	11.057984	9.972857
63	28.155675	22.887293	19.075080	16.242458	14.084371	12.402005	11.062371	9.975325
64	28.306481	22.968551	19.119124	16.266470	14.097637	12.409264	11.066395	9.977568
65	28.452894	23.046683	19.161071	16.289123	14.109941	12.415989	11.070087	9.979607
66	28.595043	23.121811	19.201020	16.310493	14.121440	12.422209	11.073475	9.981461
67	28.733052	23.194049	19.239066	16.330654	14.132187	12.427971	11.076582	9.983146
68	28.867041	23.263509	19.275301	16.349673	14.142231	12.433307	11.079433	9.984679
69	28.967127	23.330297	19.309811	16.367616	14.151618	12.438247	11.082049	9.986071
70	29.123424	23.394516	19.342677	16.384544	14.160391	12.442822	11.084448	9.987338
71	29.246043	23.456266	19.373978	16.400513	14.168590	12.447057	11.086650	9.988489
72	29.365090	23.515640	19.403789	16.415578	14.176252	12.450979	11.088670	9.989535
73	29.480670	23.572731	19.432180	16.429791	14.183413	12.454610	11.090523	9.990487
74	29.592884	23.627626	19.459219	16.443199	14.190106	12.457973	11.092223	9.991351
75	29.701829	23.680410	19.484970	16.455848	14.196361	12.461086	11.093782	9.992138
76	29.807601	23.731163	19.509495	16.467781	14.202207	12.463969	11.095213	9.992852
77	29.910293	23.779965	19.532853	16.479039	14.207670	12.466638	11.096526	9.993502
78	30.009993	23.826889	19.555098	16.489659	14.212776	12.469109	11.097730	9.994093
79	30.106789	23.872009	19.576284	16.499673	14.217547	12.471397	11.098835	9.994630
80	30.200766	23.915393	19.596461	16.509131	14.222007	12.473516	11.099849	9.995118
81	30.292006	23.957109	19.615677	16.518048	14.226175	12.475478	11.100778	9.995562
82	30.380589	23.997220	19.633978	16.526460	14.230070	12.477295	11.101632	9.995965
83	30.466591	24.035789	19.651408	16.534396	14.233710	12.478977	11.102414	9.996332
84	30.550088	24.072874	19.668007	16.541833	14.237113	12.480534	11.103132	9.996666
85	30.631154	24.108533	19.683816	16.548947	14.240292	12.481076	11.103791	9.996969
86	30.709858	24.142820	19.698873	16.555610	14.243264	12.483311	11.104396	9.997244
87	30.786270	24.175788	19.713212	16.561896	14.246041	12.484548	11.104950	9.997495
88	30.860457	24.207439	19.729869	16.567827	14.248637	12.485692	11.105459	9.997723
89	30.932482	24.237970	19.739875	16.573421	14.251062	12.486751	11.105925	9.997930
90	31.002410	24.267279	19.752262	16.578699	14.253329	12.487734	11.106354	9.998118
91	31.070301	24.295461	19.764059	16.583679	14.255448	12.488642	11.106746	9.998289
92	31.136215	24.322558	19.775294	16.588376	14.257428	12.489484	11.107107	9.998444
93	31.200209	24.348614	19.785994	16.592808	14.259279	12.490263	11.107437	9.998586
94	31.262338	24.373667	19.796185	16.596988	14.261008	12.490984	11.107741	9.998714
95	31.322659	24.397757	19.805891	16.600932	14.262625	12.491652	11.108019	9.998831
96	31.381222	24.420900	19.815134	16.604653	14.264135	12.492271	11.108274	9.998937
97	31.438080	24.443193	19.823937	16.608163	14.265547	12.492843	11.108509	9.999034
98	31.493281	24.464608	19.832321	16.611475	14.266866	12.493373	11.108723	9.999122
99	31.546875	24.485200	19.840306	16.614599	14.268099	12.493864	11.108921	9.999202
100	31.598908	24.505000	19.847910	16.617546	14.269252	12.494319	11.109101	9.999274
F.S.	33.333333	25.000000	20.000000	16.666667	14.285714	12.500000	11.111111	10.000000



*The Use of the preceding Tables.*

The Amount or present Value of any Sum of Money, for any Number of Years, not exceeding 100, at any of the aforefaid Rates of Interest, is thus found:

Look in the first or second Table for the Number of Years, and even with that Number, under the Rate of Interest, is the Amount or present Value of 1 *l.* which Amount or present Value so found, being multiply'd by the principal Sum, the Product is the Amount or present Value requir'd.

After the same manner, the Amount or present Value of any Annuity, or other yearly Payment, is found by the third or fourth Table.

*Examples.*

Quest. 1. *What will 125 *l.* amount unto in 15 Years, at 5 *l.* per Cent. per Ann. Compound Interest?*

In Table I. even with 15 Years, and under 5 *l.* per Cent. I find the Amount of 1 *l.* to be

Which multiply'd by the Principal — — — 125

The Product will be — — — 259.866, &c.

Ans. 259 *l.* 17 *s.* 4 *d.*

Quest. 2. *What is the present Value of 259 *l.* 17 *s.* 4 *d.* to be paid at the End of 15 Years, discounting at the Rate of 5 *l.* per Cent. per Ann. Compound Interest?*

In Table II. even with 15 Years, and under 5 *l.* per Cent. I find the present Value of 1 *l.* to be

Which multiply'd by the Principal 259.8667

The Product will be — — — 125.000, &c.

Ans. 125 *l.*

Quest. 3. *What will 15 *l.* per Ann. amount unto in 21 Years, at 8 *l.* per Cent. per Ann. Compound Interest?*

In Table III. even with 21 Years, and under 8 *l.* per Cent. I find the Amount of 1 *l.* per Ann. to be

Which multiply'd by — — — 15

The Product will be — — — 756.343815

Ans. 756 *l.* 6 *s.* 10  $\frac{1}{2}$  *d.*

Quest. 4. *What is the present Value of 15 *l.* per Ann. for 21 Years to come, at 8 *l.* per Cent. per Ann. Compound Interest?*

In Table IV. even with 21 Years, and under 8 *l.* per Cent. I find the present Value of 1 *l.* per Ann. to be

Which multiply'd by — — — 15

The Product will be — — — 150.252075

Ans. 150 *l.* 5 *s.* 0  $\frac{1}{2}$  *d.*

Quest. 5. *What will 150 *l.* 5 *s.* 0  $\frac{1}{2}$  *d.* amount unto in 21 Years, at 8 *l.* per Cent. per Ann. Compound Interest?*

In Table I. even with 21 Years, and under 8 *l.* per Cent. I find the Amount of 1 *l.* to be

Which multiply'd by — — — 150.252

The Product will be — — — 756.343, &c.

Ans. 756 *l.* 6 *s.* 10  $\frac{1}{2}$  *d.*

Which Answer is the same with that given to the third Question, and shews the Agreement of the Tables one with the other.

Quest. 6. *One having the Lease of an Estate, Value 60 *l.* per Ann. more than the reserv'd Rent, 12 Years to come, would know what Sum ought to be paid, to add 28 Years to the Term, and thereby make it 40 Years to come, computing at the Rate of 6 *l.* per Cent. per Ann. Compound Interest?*

I find in Table IV. the present Value of 1 *l.* per Ann. for 40 Years to come, at 6 *l.* per Cent. per Ann. to be

I find in the same Table the Value of 1 *l.* per Ann. for 12 Years to come, at the same Rate, to be

The Difference is — — — 6.662453

Which multiply'd by — — — 60

The Product will be — — — 399.747180

Ans. 399 *l.* 14 *s.* 11  $\frac{1}{4}$  *d.*

Quest. 7. *A has the Possession of an Estate of 100 *l.* per Ann. 15 Years to come, B has the Reversion of the same Estate for ever, after the Expiration of the said 15 Years. It is demanded, What is the present Value of A's Term of 15 Years? And, What the present Value of B's Reversion, computing at the Rate of 5 *l.* per Cent. per Ann. Compound Interest?*

I find in the last Line of Table IV. under 5 *l.* per Cent. the Fee Simple of 1 *l.* per Ann. to be worth 20 *l.* which multiply'd by 100, the Product is

I find in the same Table, the Value of 1 *l.* per Ann. 15 Years to come, at the same Rate, to be 10.379658; which multiply'd by 100, the Product is

The Difference is — — — 962.0342

Ans. 1037 *l.* 19 *s.* 3  $\frac{3}{4}$  *d.* the Possession of 15 Years to come.  
962 *l.* 0 *s.* 8  $\frac{1}{4}$  *d.* the Reversion after the said 15 Years.

2000 *l.* — — the Fee Simple.

Quest. 8. *For a Lease of certain Profits for seven Years, A makes two Offers, either to pay 150 *l.* as a Fine, and 300 *l.* per Ann. or 1700 *l.* Fine, without any Rent. B bids 650 *l.* Fine, and 200 *l.* per Ann. And C 200 *l.* Fine, and 405 *l.* per Ann. The Question is, which is the best Offer, and what the Difference, computing at the Rate of 5 *l.* per Cent. per Ann. Compound Interest?*



The Amount of 1 l. in 7 Years  
at 5 l. per Cent. (in Table I.) multi-  
plied by 150 l. is

	l.	s.	d.
	211	01	03½

The Amount of 1 l. per Ann. in  
7 Years, at 5 l. per Cent. (in Table  
III.) multiplied by 300 l. is

	l.	s.	d.
	2442	12	00½

Therefore A's first Offer, at the  
End of 7 Years, will amount unto

	l.	s.	d.
	2653	13	04

The Amount of 1 l. in 7 Years,  
at 5 l. per Cent. multiplied by 1700 l.  
is what A's 2d Offer will amount  
to in the same time.

	l.	s.	d.
	2392	01	05

The Amount of 1 l. in 7 Years,  
at 5 l. per Cent. multiplied by 650 l.  
is

	l.	s.	d.
	914	12	03½

The Amount of 1 l. per Ann. in  
7 Years, at 5 l. per Cent. multiplied  
by 200 l. is

	l.	s.	d.
	1628	08	00½

Therefore B's Offer, at the End  
of 7 Years, will amount unto

	l.	s.	d.
	2543	00	04

The Amount of 1 l. in 7 Years,  
at 5 l. per Cent. multiplied by 200 l.  
is

	l.	s.	d.
	281	08	05

The Amount of 1 l. per Ann. in  
7 Years, at 5 l. per Cent. multiplied  
by 405 l. is

	l.	s.	d.
	3297	10	03

Therefore C's Offer, at the End  
of 7 Years, will amount unto

	l.	s.	d.
	3578	18	08

The Amounts of the said Offers, at the End of  
the said Term, being thus known, look (in Tab. II.)  
for the present Value of 1 l. payable at the End of  
7 Years, at 5 l. per Cent. which will be found to be  
.710682. Which said Value being multiplied by  
the said several Amounts, the Products will be the  
present Value of the said several Offers, viz.

	l.	s.	d.
The present Value of A's 1st will be	1885	18	03
A's 2d	1700	00	00
B's —	1807	05	06
C's —	2543	09	08

Therefore the present Value of what C offers is  
more than A's 1st 657 11 05  
A's 2d 843 09 08  
B's — 736 04 02

Which answers the Question.

Or thus;

A's 1st Offer is 300 l. per Ann. the  
present Value of which, for 7  
Years, at 5 l. per Cent. is

	l.	s.	d.
	1735	18	03

And a Fine of — — 150 00 00

	l.	s.	d.
	1885	18	03

A's 2d Offer is a Fine of 1700 00 00

B's Offer is 200 l. per Ann. the  
present Value of which, for 7 Years,  
at 5 l. per Cent. is

	l.	s.	d.
	1157	05	06

And a Fine of — — 650 00 00

	l.	s.	d.
	1807	05	06

C's Offer is 405 l. per Ann. the  
present Value of which, for 7 Years,  
at 5 l. per Cent. is

	l.	s.	d.
	2343	09	00

And a Fine of — — 200 00 00

	l.	s.	d.
	2543	09	08

Therefore C's is more than A's 1st 657 11 05  
A's 2d 843 09 08  
B's — 736 04 02

Quest. 9. A gives 1550 l. for an Annuity of 100 l.  
per Ann. for 99 Years. B puts 1550 l. out at Inte-  
rest. It is requir'd to know, which will amount to  
the greatest Sum at the End of the said 99 Years, at  
the Rate of 6 l. per Cent. per Ann. Compound In-  
terest?

The Amount of 1 l. per Ann.  
in 99 Years, at 6 l. per Cent. (in  
Tab. III.) multiplied by 100 l. is

	l.	s.	d.
	531827	03	06

The Amount of 1 l. in 99 Years,  
at 6 l. per Cent. (in Tab. I.) multi-  
plied by 1550 l. is

	l.	s.	d.
	496149	05	5½

Therefore A's 100 l. per Ann.  
will amount to more than B's  
1550 l. in that Term.

	l.	s.	d.
	35677	18	0½

Which answers the Question.

If the present Value of that Difference is requi-  
red, find the present Value of 1 l. payable at the  
End of 99 Years, at 6 l. per Cent. (in Tab. II.) which  
multiplied by the Difference, the Product will be  
the present Value thereof, viz. 111 l. 9 s. 2 d.

The present Value of the Difference is likewise  
thus found:

Find the present Value of 1 l.  
per Ann. for 99 Years to come,  
at 6 l. per Cent. (in Table IV.)  
which multiplied by 100 l. the  
Product will be

	l.	s.	d.
	1661	09	02

Which is the present Value of  
100 l. per Ann. for 99 Years, at  
6 l. per Cent.

And from which subtract 1550 00 00

There will remain — — 111 09 02

Which is the present Value of the Difference.

Or thus:

The Interest of B's 1550 l. at 6 l. per Cent. is  
93 l. per Ann. Therefore A receives 7 l. per Ann.  
more than B.

The present Value of 7 l. per  
Ann. for 99 Years to come, at 6 l.  
per Cent. is

	l.	s.	d.
	116	06	00

The present Value of 1550 l. to  
be paid at the End of 99 Years, is

	l.	s.	d.
	4	16	10

Therefore the present Value of  
the Difference, is

	l.	s.	d.
	111	09	03

After the same manner most other useful Que-  
stions in Compound Interest are easily answer'd.



INTERFORAMINEUM, or *Interfemineum*, the same with *Perineum*.

INTERJECTION, in Grammar, is an indeclinable Word used in a Sentence, to declare the Affections or Passions of the Mind, and to compleat the Sense of it.

INTERIOR Polygon: see *Polygon Interior*.

INTERIOR Talus: see *Talus*.

INTERLOCUTORY Order, is that which decides not the Cause, but only settles some intervening Matter relating to the Cause; as where an Order is made by Motion in *Chancery*, for the Plaintiff to have an Injunction to quit his Possession till the hearing of the Cause; this, or any other such Order not being final, is *Interlocutory*.

INTERMISSIO *Februm*: see *Apyrexia*.

INTERMITTENS *Morbus*, is a Disease which comes at certain times, and then remits a little.

INTERNAL Angles: see *Angles Internal*.

INTERNODIUM, in Botany, is the Space contained between any two Knots or Joints of the Stalk of a Plant.

INTERNUS *Auris*, is a Muscle which lies in a Bony Channel evacuated in the *Os Petrosum*, which makes one of the *Parietes Tympani*: One part of this Channel is without the *Tympanum*, and lies in the upper part of the Bony Passage which goes from the Ear to the Palate; the other part, which is within the *Tympanum*, advancing as far as the *Fenestra Ovalis*, makes in that Place a rising, upon which, as on a Pulley, the Tendon of this Muscle passes to the other Side of the *Tympanum*, and inserts itself at the posterior Part of the Handle of the *Malleus*, a little below the Insertion of the External Muscle, by which means it draws towards the *Os Petrosum*. When this Muscle acts it pulls the *Manubrium* of the *Malleus* towards the *Os Petrosum*, whereby the *Membrana Tympani* becomes somewhat concave outwardly.

INTEROSSEI *Manus*, are the Muscles of the Fingers, which are distinguished into External and Internal; they are aptly so named from their Situations. Authors disagree in their Number, some reckoning six, others eight, amongst which they esteem the *Abductor Minimi Digiti*, and *Indicis*; but Mr. Cowper inclines to the first Opinion, conceiving the two latter named Muscles do not deserve these Denominations. They arise fleshy internally in the Palm from the superior Parts of the Metacarpal Bones next the *Carpus*, whence descending, they become Tendinous at the first Internode of each Finger laterally, and pass to their Insertions with the *Extensor Digitorum Communis*; each Interstice of the Metacarpal Bones entertaining two Muscles inserted to the Sides of the Fingers. When all these *Interossei* act together, they draw the Fingers near each other, and assist in their Extension, as *Galen* takes notice; at which time they, together with the *Abductor Indicis*, and *Minimi Digiti*, are capable of divaricating the Fingers, which Action cannot be performed without some Difficulty by them when they are bended; which Contrivance of the most Wise Architect is also observed by *Galen*.

INTEROSSEI *Pedis*, are Muscles of the Foot; they are reckoned to be seven in Number. They derive their Names from their Situation, and may each deserve a proper Appellation from their Use.

The First may be called *Abductor Minimi Digiti*.

The Second, which is the largest, draws the next Toe towards the lesser, and may be called, *Abductor Auricularius*.

The Third antagonizes the former, and is an *Abductor* of the Toe.

The Fourth may be called *Abductor Medii Digiti*.

The Fifth is an *Abductor* of the same.

The Sixth is an *Abductor*; and Seventh, *Abductor Indicis Pedis*.

All these arise fleshy from the superior Part of the *Ossa Metatarsi* of the lesser Toes, and becoming bellied, grow Tendinous at their Insertions to the first Internode of each lesser Toe laterally.

INTERROGATION, is a Figure in Rhetorick, in which the Passion of the Speaker introduces a thing by way of Question, to make its Truth the more conspicuously appear.

INTERRUPTION, as some call it, is the same with Disjunction of Proportion in Geometry, and is noted thus, ( $:$ ) and signifieth the breaking off of the Ratio in the middle of four disjunct or discrete Proportionals, As  $A : B :: C : D$ ; that is, As  $A$  is to  $B ::$  So is  $C$  to  $D$ .

INTERSCAPULARIA, are the Cavities betwixt the Shoulder-blades and the Vertebres.

INTERSECTION, in Mathematicks, signifies the cutting of one Line or Plane by another: Thus we say, that the mutual *Intersection* of two Planes, is a Right Line.

INTERSPERSUM *Vacuum*: see *Vacuum*.

INTERSPINALES *Colli*; these are small fleshy Muscles of the Neck, arising from the superior Parts of each double spinal Process of the Neck, except of the second *Vertebra*; and are inserted to the inferior Parts of all the said double Spines. When these Muscles act, they draw the Spines of the *Vertebrae* of the Neck nearer each other. These were first discovered in the Year 1690.

INTERSTELLAR, a Word used by some Authors, to express those Parts of the Universe that are without and beyond our Solar System; and which are supposed as Planetary Systems moving round each fix'd Star as the Center of their Motion, as the Sun is of ours: And if it be true, as 'tis not improbable, That each fix'd Star may thus be a Sun to some habitable Orbs that may move round it, the *Interstellar* World will be infinitely the greater Part of the Universe.

INTERTIES, in a Building, are those small Pieces of Timber that lie horizontally between the Sommers, or between *them* and the *Sell* or *Reason*.

INTERTRANSVERSALES *colli* [in *Anatomy*], certain Muscles between the transverse Processes of the *Vertebrae* of the Neck, of the same Size and Figure with the *Interspinales*.

INTERTRIGO, or *Attritus*, is cutting or fretting the *Cuticula* off of the Parts near the Fundament, or betwixt the Thighs.

INTERVAL, in Musick, is the Distance or Difference between any two Sounds, whereof one is more Grave, and the other more Acute. They make several Divisions of an *Interval*, as first into *Simple* and *Compound*: The *Simple Intervals* are the *Octave*, and all that are within it, as the *Second*, *Third*, *Fourth*, *Fifth*, *Sixth*, and *Seventh*, with their Varieties: The *Compound* ones are all those that are greater than an *Octave*, as the *Ninth*, *Tenth*, *Eleventh*, &c. with their Varieties.

An *Interval* is also divided into *Just* or *True*, and into *False*: All the above-mentioned *Intervals*, with their Varieties, whether *Major* or *Minor*, are *Just*; but the diminutive or superfluous ones are all *False*: See *Ozanam's Dict. Matth.* p. 653. An *Interval* is also divided into a *Consonance* and a *Dissonance*; which see.

INTERVAL



**INTERVAL** of the Fits of easy Reflection, and of easy Transmission of the Rays of Light, is the Spaces between every Return of the Fit, and the next Return.

These *Intervals* Sir *Is. Newton* shews how to collect, and thence to determine whether the Rays shall be reflected or transmitted at their subsequent Incidence on any pellucid *Medium*. See *Light*, &c. and *Newton's Opticks*, Book 2. Part 3.

**INTESTATES**, in Law; there are two kinds of *Intestates*; one that makes no Will at all; another that makes a Will, and nominates Executors, but they refuse; in which he dies as an *Intestate*, and the Ordinary commits Administration.

**INTESTINES**, the *Entrails*, *Guts*, or *Bowels*. They are a long and large Pipe, which by several Turnings and Windings reaches from the *Pylorus* to the *Anus*: They are knit all along the Edge of a Membrane call'd the *Mesentery*, and are usually six times as long as the Body to which they belong; that so the Chyle, which escapes the Lacteals of one of the Guts, may be taken up by those in the next. They have three Coats, of which the inmost is made up of short Fibres bound together by fine Blood-Vessels, and disposed as those of the Stomach: For the Length of a Fibre is the Thickness of the Coat. This Coat, being much larger than the other, lies in Wrinkles or Plaits, which are call'd *Valvulae Conniventes*. It hath also a great Number of little Glands, which in the small Guts lie in Clusters every where, but where they are knit to the *Mesentery*. These Glands seem to separate a Liquor for the diluting of the thick Chyle, that it may the more easily enter the small Orifices of the Lacteals. The second Coat is made up of two Orders of Muscular Fibres, one running strait, according to the Length of the Guts; the other goes round, describing rather a spiral than a circular Line. By the successive Motion of these two Orders of the Fibres, the Guts are in a continual Undulation; which is called the *Vermicular* or *Peristaltick* Motion of the *Intestines*. The third and external Coat is common, and comes from the *Peritoneum*.

The *Intestines*, tho' properly but one continued Pipe, yet are divided into six Parts; three thin and small, and three thick and great. The thin and small are the *Duodenum*, the *Jejunum*, and *Ileum*. Thick and great Guts are the *Cecum*, *Colon*, and *Rectum*. See those Words.

**INTESTINE Motion** of the Parts of Fluids. Where the attracting Corpuscles of any Fluid are elastick, they must necessarily produce an *Intestine Motion*; and this greater or lesser, according to the Degrees of their Elasticity and attractive Forces.

For two elastick Particles, after meeting, will fly from one another (abstracting from the Resistance of the *Medium*) with the same Degree of Velocity that they met together with. (See *Elasticity*.) But when in leaping back from one another they approach other Particles, their *Velocity* will be increased.

**INTRENCHMENTS**, are all Sorts of Works made to fortify any Post against an Enemy: There is usually a Ditch with a Parapet, or Rows of Fascines loaded with Earth, Gabions, Sand-bags, or Hogsheds filled with Earth to cover the Men from the Fire.

**INTRUSION**, is when the Ancestor dies seized of any Estate of Inheritance, expectant upon an Estate for Life; and then the Tenant for Life dies, between whose Death, and the Entry of the Heir, a Stranger does interpose and *intrude*.

**INTRUSIONE**, is a Writ that lies against the *Intruder*.

**INTUITION**, according to Mr. *Locke*, is the Perception of the certain Agreement or Disagreement of any two Ideas immediately compared together.

**INVADIATIONES**, was a Term formerly used in the Law for *Mortgages* and *Pledges*: And so *Invadiare* was to mortgage Land.

**INVADIATUS**, in Law, is when one has been accused of some Crime, which being not fully proved, he is put *sub debita fidei jussione*; i.e. *Suretiship*.

**INVECTED**, a Term in Heraldry, signifying directly contrary to *Engrailed*; which see.

**INVENTION**, in Painting, Sculpture, &c. is the Art of finding out proper Objects for a Picture, by the Help of History or ancient Fables, &c.

**INVENTIONES**, was the Term formerly for what is now called *Treasure-Trove*, viz. Money or Goods found by any Person, and not challeng'd by any Owner: Which therefore by Common Law was due to the King (whence that old Rhyme used to this Day in many Countries by the Children,

*Who has lost? I have found.*

*In the King's Holy Ground*)

And King *Edward I.* we find, granted to the *Barons of the Ports*, *Inventiones suas per Mare & Terras*, &c.

**INVENTORY**, is the Description or Repertory orderly made of all dead Mens Goods and Chattels, prized by four or more credible Men, which every Executor or Administrator is bound to exhibit to the Ordinary at such times as he shall appoint.

**INVERSE Proportion**, or *Proportion by Inversion*: see the Word *Proportion*, N. 7.

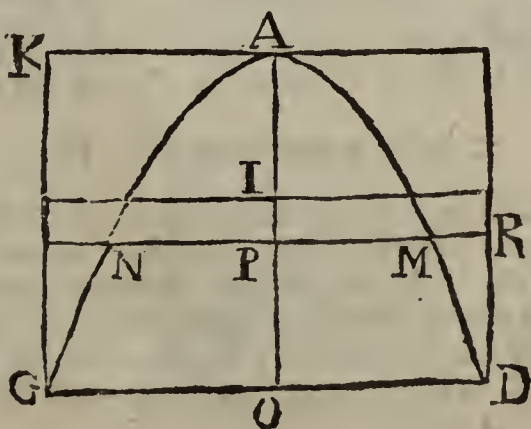
**INVERSE Method of Fluxions**, is the Method of finding the *Flowing Quantity* from the *Fluxion* given; and is the same with what the foreign Mathematicians call the *Calculus Integralis*: On which Subject there is a Treatise publish'd in *French* by Mr. *Carré*, A. D. 1700, Printed at *Paris*.

Some call it *Summatory Arithmetick*; and the Reason and Foundation of it Mr. *Hayes* shews in his Book of *Fluxions*.

He had, in *Prop 2.* of his fourth Section, been shewing how to *investigate the Areas of Hyperbolic Form Figures*: And in *Cor. 3.* of that Proposition, he shews that 'tis manifest, that any *Parabola*, or the Complement of any *Parabola*, to the circumscribed Parallelogram; or an *Hyperbola* being given: And supposing the Ordinate (See *Fig. 2. annex'd*)  $PM=y$ ; the Abscissa  $AP=x$ ;  $PR=OD=b$ ; the Axis  $OA=c$ : That all the  $PR$ , or  $b$ 's are : to all the  $PM$ , or  $y$ 's :: as  $m \mp 1$  : is to  $m$ .

And if it be required to find what Proportion all the  $b$ 's, advanced to any Power  $n$ , has to all the  $y$ 's advanced to the same Power  $n$ , it may be thus investigated.

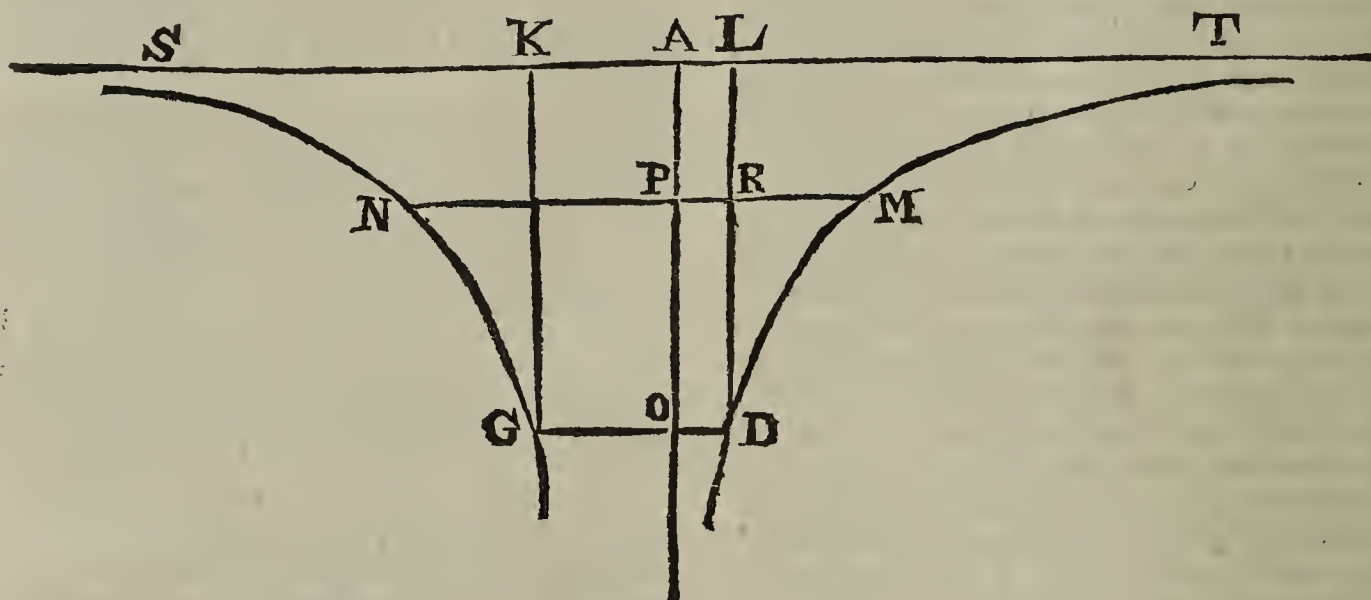
Suppose the new Curve  $NG$  to be described, so that  $PN$  be always equal or proportional to  $\overline{PM}^n$  or  $y^n$ , then it is manifest that the Sum of





all the  $y^n$  is equal to the Sum of all the  $P N$ , or to the curvilinear Space  $O A G N$ : And because  $y^n$  is always equal or proportional to  $P N$ , and  $P N$  becomes equal to  $O G$ , at the same time that  $y^n$  becomes equal to  $b^n = \overline{O D}^n$ ; 'tis likewise manifest, that the Sum of all the  $b^n$  is equal or pro-

portional to the Sum of all the  $O G$ , or the Parallelogram  $A O G K$ . Whence it appears, that to investigate the Proportion of all the  $y^n$  to all the  $b^n$  is the same thing as to investigate the Proportion of the Curvilinear Space  $A O G N$  to the Parallelogram  $A O G K$ . Which may be done thus: In Parabo-



loids and Hyperboloids, the general Equation expressing the Nature of such Curves is  $y^m = x$ , and consequently  $y^n = x^{\frac{n}{m}}$ . Now suppose  $y^n = z$ , then  $z = x^{\frac{n}{m}}$ , and  $z^m = x^n$ , which is an Equation, expressing the Nature of a Paraboliform, or Hyperboliform Curve.

Let the said Curve be  $ANG$ , and  $AP = x$ ,  $AO = c$ ,  $PN = z$ , and  $OG = d$ . Then (*Hayes Sect. 3. Art. 90.*)  $\frac{m}{n} \pm 1 : \frac{m}{n} :: (m \pm n : m)$  all the  $d$  : to all the  $z$ . And because  $z$  was put equal to  $y^n$ ; therefore when  $z$  or  $PN$  becomes  $OG$  or  $d$ , then  $y^n$  becomes  $b^n$ ; and consequently  $d$  is  $= b^n$ ; therefore  $m \pm n : m :: S : b^n : S : y^n$ .

Hence we may easily deduce the 64th Prop. Arith. Infinit. first discovered by the Learned Dr. Wallis.

#### CONSECTARY I.

1. For we found before  $z = x^{\frac{n}{m}}$ , and it is also  $m : m + n :: 1 : 1 + \frac{n}{m} :: y^n : b^n$ . in the direct Series, and  $1 : 1 - \frac{n}{m} ::$  all the  $y^n$  : all the  $b^n$ . in the Negative Series. Whence it is evident, that if the Exponent of the Power of the intercepted Diameter  $x$ , be taken for the Index of the Series, it will be as 1 is to the Power of the intercepted Diameter or Index of the Series (because  $z = y^n = x^{\frac{n}{m}}$ ; and consequently  $x^{\frac{n}{m}}$  represents  $y^n$  in the Dimension requir'd) increas'd by Unity; so are all the  $y^n$  to all the  $b^n$ .

#### CONSECTARY II.

2. Hitherto we have found the Proportion of all the  $y^n$ , or (multiplying both by the Fluxion  $\dot{x}$ )  $y^n \dot{x}$  to all the  $b^n \dot{x}$ , their absolute Value may be found thus: It was by the preceding Corollary,  $m : m \mp n ::$  all the  $z \dot{x}$  : all the  $d \dot{x}$ ; that is, so is the Space  $A O G N$ , to the Rectangle  $A O G K = dc$ : There-

fore  $\frac{m d c}{m \mp n} =$  all the  $z \dot{x} = S : y^n \dot{x}$ , (because  $z = y^n$ .) But  $b^n = d$ . Therefore  $S : y^n \dot{x} = \frac{m d c}{m \mp n} = \frac{m c b^n}{m \mp n} = \frac{1 c b^n}{1 \mp \frac{n}{m}}$ .

#### CONSECTARY III.

3. And if we suppose the Index  $\mp \frac{n}{m} = \mp \mu$ , then the Value of all the  $y^n \dot{x}$  is  $= \frac{1 c b^n}{1 \mp \mu}$ ; and again, If in the Place of  $b^n$  we substitute  $c^{\mp \mu}$  (because  $y^n = x^{\mp \frac{n}{m}}$ , that is, when  $y$  becomes  $= b$ , and  $x = c$ ,  $c^{\mp \frac{n}{m}} = b^n = c^{\mp \mu}$ ) we shall have all the  $y^n \dot{x} = \frac{c^{\mp \mu}}{1 \mp \mu}$ .

#### CONSECTARY IV.

4. Hence Mercator's Lem. Prop. 16. Logarithmotechn. may be deduced, upon which the Learned Dr. Gregory's Geometrical Exercise chiefly depends.

For because all the  $y^n \dot{x}$  are  $=$  all the  $x^{\mp \mu} \dot{x}$ , it is evident, that (rejecting the invariable Quantities, if

there be any) all the  $x^{\mp \mu} \dot{x} = \frac{c^{\mp \mu}}{1 \mp \mu}$  (by put-

ting the greatest  $x = c$ )  $\frac{c^{\mp \mu}}{1 \mp \mu}$ . Whence we have

the Demonstration of the fundamental Rule in Summatory Arithmetick, to find the flowing Quantity of a given Fluxion.

#### CONSECTARY V.

5. For Instance, if the Right Line  $AO = c$  be divided into an infinite Number of  $\dot{x}$ , the Sum of all the Rectangles contain'd under any Power of the Abscissa



Abscissa  $x$ , and all the  $\dot{x}$  respectively, that is, the Sum of all the  $x^{\frac{m}{n}}$ , or the *Flowing Quantity*, whereof  $x^{\frac{m}{n}}$  is the Fluxion, is equal to  $\frac{x^{\frac{m}{n}+1}}{1+\frac{m}{n}} = \frac{x^{\frac{m+n}{n}}}{\frac{n+m}{n}} = \frac{n}{n+m} x^{\frac{n+m}{n}}$  to the Power of  $x$  increased by Unity, and divided by the new Exponent. And seeing the Thread of my Discourse has led me on to this Head, I shall insist more at large on the same in the next.

### PROP. I.

*To find the flowing Quantity of any Fluxion.*

The summing up of Infinites, or finding the Sum of all the Fluxions of an unknown Quantity, or the finding the flowing Quantity from its Fluxion given, is not less difficult in many Cases, than the Reverse is easy. I shall begin with the easiest Examples, and proceed gradually to those that are more intricate and difficult.

#### Example I.

Let it be required to find the flowing Quantity of this Fluxion  $a a \dot{x}$ , or  $a a x^0 \dot{x}$ ; to the Index of the flowing Quantity add 1, and then we have  $a a x^{0+1} \dot{x}$ ; divide this by the fluxionary Letter  $\dot{x}$ , and by the new Index  $0+1$ , or 1, the Quotient  $a a x$  is the flowing Quantity of the given Fluxion.

#### Example II.

Let it be required to find the flowing Quantity of  $a y \dot{x} + a x \dot{y}$ ; the flowing Quantity of the first Member  $a y \dot{x}$  is  $= a x y$ ; and that of the second Member  $a x \dot{y}$  is  $= a x y$ : Whence it is plain, that the flowing Quantity of  $a y \dot{x} + a x \dot{y}$  is  $= a x y$ .

#### Example III.

Let it be required to find the flowing Quantity of  $3 x x \dot{x}$ ; increase the Index of the flowing Quantity  $x$  by 1, and then we have  $3 x^3 \dot{x}$ , which divide by the new Index 3, and by the fluxionary Letter  $\dot{x}$ , then the Quotient  $= \frac{3 x^3 \dot{x}}{3 \times \dot{x}} = x^3$  is the flowing Quantity of the given Fluxion.

And universally;

If it be requir'd to find the flowing Quantity of  $m x^{m-1} \dot{x}$ , increase the Index of the flowing Quantity  $x$  by 1, and then we have  $m x^m \dot{x}$ , which divide by the new Index  $m$ , and by the fluxionary Letter  $\dot{x}$ , and there will arise  $x^m$  for the flowing Quantity requir'd.

#### Example IV.

Let it be requir'd to find the flowing Quantity of  $\frac{a \dot{x}}{x x}$ ; the Fluxion (*Hayes, Art. 16.*) express'd by the other way of Notation, is  $a x^{-2} \dot{x}$ , and the flowing Quantity thereof is  $= \frac{a x^{-2}}{-2} = -\frac{a}{2x}$ . Thus the

flowing Quantity of  $\frac{a \dot{x}}{x x} = \frac{a \dot{x}}{x^2} = a x^{-2} \dot{x}$  is  $=$

$$-\frac{a}{2x}.$$

### Example V.

Let it be required to find the flowing Quantity of  $\frac{-2 \dot{x}}{x^4} = -2 x^{-4} \dot{x}$ . To the Index of the Power of the flowing Quantity add 1, and divide by the new Exponent, and by  $\dot{x}$ , the Quotient is  $= \frac{-2}{-4} x^{-3} = \frac{1}{2} x^{-3} = \frac{1}{2x^3}$  the flowing Quantity required.

### Example VI.

Let it be required to find the flowing Quantity of  $\frac{x^2 \dot{x}}{\sqrt{r x}}$ ; this Fluxion may be express'd thus,  $r^{-\frac{1}{2}} x^{\frac{5}{2}} \dot{x}$ , and then the flowing Quantity thereof is,  $\frac{2}{5} r^{-\frac{1}{2}} x^{\frac{5}{2}} = \frac{2 \sqrt{x^5}}{5 \sqrt{r}}$ .

### Example VII.

The flowing Quantity of  $\dot{x} \sqrt{2 r x}$ , or  $\dot{x} \times \frac{2 r x}{2} = \frac{2}{3} \times \frac{2 r}{2} x^{\frac{3}{2}} = \frac{2}{3} \sqrt{2 r x x x}$ , and the flowing Quantity of  $\dot{x} \sqrt{2 r x - x x}$  is found by reducing  $2 r x - x x$  to an infinite Series, and multiplying the same by  $\dot{x}$ , and then finding the flowing Quantity of every Term.

### Example VIII.

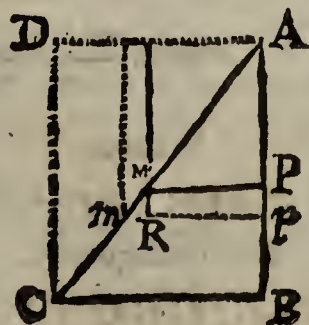
To find the Fluent of  $a \dot{x} \sqrt{a x - a a}$ . In such Cases where the Fluxion is affected with a *Vinculum*, we must consider whether the fluxional Quantity, standing before the Radical Sign, be the Fluxion of the simple or compound Quantity under the *Vinculum*; for in such Cases the Fluent may be found by the general Rule.

Thus in this Example I observe, that  $a \dot{x}$  is the Fluxion of  $a x - a a$ , and therefore the Fluent of  $a \dot{x} \sqrt{a x - a a}$  or  $a \dot{x} \times \sqrt{a x - a a}^{\frac{1}{2}}$  is  $\frac{2}{3} \times \sqrt{a x - a a}^{\frac{3}{2}} = \frac{2 a x - 2 a a}{3} \sqrt{a x - a a}$ .

In like manner the Fluent of  $\frac{r \dot{x} - x \dot{x}}{2 r x - x x}^{\frac{1}{2}}$ , or  $\frac{r \dot{x} - x \dot{x}}{2 r x - x x} \times \sqrt{2 r x - x x}^{\frac{1}{2}}$ , or  $2 r \dot{x} - 2 x \dot{x} \times \frac{1}{2} \sqrt{2 r x - x x}^{\frac{1}{2}}$  will be found (if to the Exponent  $-\frac{1}{2}$  we add 1, and divide by the new Exponent  $\frac{1}{2}$ , and by the fluxionary Quantity  $2 r \dot{x} - 2 x \dot{x}$ ) to be  $\sqrt{2 r x - x x}$ .

These Rules may be demonstrated by Induction also; and because that Method, by particular Instances, may serve to give the Reader a clearer Notion of Summatory Arithmetick, I shall explain the same in the following Examples.

i. In the Rectangular Triangle  $ABC$ : Suppose  $AB = a$ ,  $BC = b$ ,  $AP = x$ ,  $Pp = \dot{x}$ ,  $PM = y$ ; then the Equation of the Triangle is





$y = \frac{bx}{a}$ , and the infinitely little Parallelogram  $Mp$  = to the Fluxion of the Triangle, is  $= y \dot{x}$  = (by Substitution)  $\frac{bx \dot{x}}{a}$ : And the flowing Quantity is  $\frac{bx \dot{x}}{2a} = \left( \text{putting } y = \frac{bx}{a} \right) \frac{x \dot{y}}{2}$ . it remains to be proved that the Sum of all the  $y \dot{x}$  is  $= \frac{x \dot{y}}{2}$ .

Compleat the Parallelogram  $ABCD$ ; then it is evident that the Triangle  $ABC$  is equal to the Sum of all the  $y \dot{x}$ , and the Triangle  $ADC$  is equal to the Sum of all the  $x \dot{y}$ . But both these Triangles are equal to the Parallelogram, and each is equal to  $\frac{1}{2}$  the Parallelogram, and the Parallelogram is equal to  $x \dot{y}$ ; therefore all the  $y \dot{x} = \frac{x \dot{y}}{2}$  = Triangle  $ABC$ .

2. Let  $AMB$  be a Parabola,  $AP = x$ ,  $PM = y$ , the Parameter  $= 1$ ; then the Equation of the Curve is  $x^{\frac{1}{m}} = y$ , and the Fluxion of the

Parabolick Space, viz.  $Mp = y \dot{x} = x^{\frac{1}{m}} \dot{x}$ . Now it is evident, that the Sum of all those Parallelograms is equal to the Parabolick Space  $AMBD$ . And the flowing Quantity of  $x^{\frac{1}{m}} \dot{x}$  is  $\frac{m}{m+1} x^{\frac{1}{m}+1} = \left( \text{putting } y \text{ for } x^{\frac{1}{m}} \right) \frac{m}{m+1} x \dot{y}$ , which we must prove to be equal to the Sum of all the  $y \dot{x}$ .

Compleat the Parallelogram  $ADBC$ ; then it is manifest that the Space  $AMBD$  is equal to all the  $y \dot{x}$ , and the Space  $AMBC$  is equal to all the  $x \dot{y}$ . But by the Method of Tangents it is  $y : x :: y : t$ , and  $t \dot{y} = y \dot{x}$ , and in the Parabola  $t = mx$ ; ergo  $y \dot{x} = m x \dot{y}$

Whence  $1 = \frac{m x \dot{y}}{y \dot{x}}$ ,

And  $\frac{1}{m} = \frac{x \dot{y}}{y \dot{x}}$ ,

Adding 1 to each Side of the Equation  $\frac{1}{m} + 1 = \frac{x \dot{y}}{y \dot{x}} + 1$ ;



That is,  $\frac{m+1}{m} = \frac{x \dot{y} + y \dot{x}}{y \dot{x}}$ .

Whence

$m : m+1 :: y \dot{x} : x \dot{y} + y \dot{x}$ ;

And consequently,

$m : m+1 :: S : y \dot{x} : S : x \dot{y} + S : y \dot{x}$ ;

But

$S : x \dot{y} + S : y \dot{x} = x \dot{y}$ .

Therefore

$m : m+1 :: S : y \dot{x} : x \dot{y}$ ;

And consequently

$\frac{m}{m+1} \times x \dot{y} = S : y \dot{x}$ . Q E. D.

And besides the Examples I have produced, there are others which occur, to which these Rules cannot be immediately applied; and that the Reader may not be at too great a Loss in such Cases, I shall endeavour to assist him in that Particular. But first it will be necessary to premise this

### LEMM A.

If a Binomial be to be rais'd to any Power, v.g.  $m$ , (which represents any Number, whole or broken, positive or negative) then the *Unciæ* or Numbers prefix'd to the several Terms are,

$1 \times \frac{m-0}{1} \cdot 1 \times \frac{m-1}{1} \cdot \times \frac{m-2}{2} \cdot 1 \times \frac{m-3}{1} \cdot \times \frac{m-4}{2} \times \frac{m-5}{3} \times \dots$ , &c. respectively.

And if  $P + P \mathcal{Q}$  represent the Quantity to be raised to the given Power;  $P$  the first Term, and  $\mathcal{Q}$  the rest, divided by that first Term, and  $\frac{m}{n}$  the Exponent of that Root or Dimension;

Then

$$\begin{array}{c} A \qquad B \\ P + P \mathcal{Q}^{\frac{m}{n}} = P^{\frac{m}{n}} + \frac{m}{n} A \mathcal{Q} + \\ C \qquad D \\ + \frac{m-1}{2n} B \mathcal{Q} + \frac{m-2}{3n} C \mathcal{Q}^2, \&c. \end{array}$$

For Instance, if it be required to extract the Square Root of  $rr - xx$ ; that is, to raise (the Word *raise* being used indifferently for involving or evolving any *Binomial*) the Binomial  $rr - xx$  to the Power or Dimension, whose Exponent is  $\frac{1}{2}$ , then  $P = rr$ ,  $\mathcal{Q} = \frac{-xx}{rr}$ ,  $m = 1$ , and  $n = 2$ ;

and consequently,  $\sqrt{rr - xx} = r - \frac{xx}{2r} - \frac{x^4}{8r^3} - \frac{x^6}{16r^5} - \frac{5x^8}{128r^7} - \dots$ , &c.

Let it be required to raise the Binomial  $a + x$  to the Power whose Exponent is  $m$ ; or let  $m$  be the Index of the Root of the Binomial, which is to be extracted. Then,  $P = a$ ,  $\mathcal{Q} = \frac{x}{a}$ , and  $\frac{m}{n} = (n \text{ in this Case being } = 1) m$ ; therefore  $(a + x)^m$  is  $= a^m + m a^{m-1} x + m \times \frac{m-1}{2} \times a^{m-2} x^2 + m \times \frac{m-1}{2} \times \frac{m-2}{3} \times a^{m-3} x^3 + m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4} \times a^{m-4} x^4$ , &c.

By the same Method any *Trinomial*, *Quadrinomial*, &c. or *Infinito-nomial* may be raised to any given Power; v.g. To raise the *Infinito-nomial*  $a + bx + cx^2 + dx^3 + \dots$  to the Power



whose Exponent is  $m$ : In the preceding *Binomial Theorem*,

Instead of  $x$  put  $\sqrt{bz + cz^2 + dz^3, \&c.}$ , and instead of  $x^2$  substitute  $\sqrt{bz + cz^2 + dz^3, \&c.}^2$ . Then it is manifest that  $a + \sqrt{bz + cz^2 + dz^3, \&c.}^m$  is  $= a^m + m a^{m-1} \times \sqrt{bz + cz^2 + dz^3, \&c.} + m \times \frac{m-1}{2} a^{m-2} \times \sqrt{bz + cz^2 + dz^3, \&c.}^2 + m \times \frac{m-1}{2} \times \frac{m-2}{3} a^{m-3} \times \sqrt{bz + cz^2 + dz^3, \&c.}^3 + m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4} a^{m-4} \times \sqrt{bz + cz^2 + dz^3, \&c.}^4 + \&c.$

### Example I.

Let it be required to find the flowing Quantity of this Fluxion  $\dot{x} \sqrt{rr - xx}$ . Reduce  $\sqrt{rr - xx}$  to an (*Hayes's Art.* 93.) Infinite Series, and then  $\sqrt{rr - xx}^{\frac{1}{2}}$  is  $= r - \frac{xx}{2r} - \frac{x^4}{8r^3} - \frac{x^6}{16r^5} - \frac{5x^8}{128r^7} - \&c.$  And consequently,  $\dot{x} \sqrt{rr - xx}$  is  $= r\dot{x} - \frac{x^2\dot{x}}{2r} - \frac{x^4\dot{x}}{8r^3} - \frac{x^6\dot{x}}{16r^5} - \frac{5x^8\dot{x}}{128r^7} - \&c.$  And finding the flowing Quantity of every Term of this Series, then the Sum of all the  $\dot{x} \sqrt{rr - xx}$  is  $= rx - \frac{x^3}{6r} - \frac{x^5}{40r^3} - \frac{x^7}{112r^5} - \frac{5x^9}{1152r^7} - \&c.$  Q. E. I.

### Example II.

It is required to find the flowing Quantity of  $\frac{rr\dot{x}}{r+x}$ . It is evident from the (*Hayes's Art.* 16.) Notation of Powers, that  $\frac{rr}{r+x}$  is  $= rr \times \frac{1}{r+x}$ . But  $\frac{1}{r+x}$  is  $=$  (*Hayes's Art.* 93.)  $r^{-1} - \frac{x}{rr} + \frac{xx}{r^3} - \frac{x^3}{r^4} + \&c.$  And consequently  $\frac{rr}{r+x}$  or  $rr \times \frac{1}{r+x}$  is  $= r - x + \frac{xx}{r} - \frac{x^3}{r^2} + \&c.$  and  $\frac{rr\dot{x}}{r+x}$  is  $= r\dot{x} - x\dot{x} + \frac{x^2\dot{x}}{r} - \frac{x^3\dot{x}}{r^2} + \&c.$  and the flowing Quantity of  $\frac{rr\dot{x}}{r+x}$  is  $= rx - \frac{xx}{2} + \frac{x^3}{3r} - \frac{x^4}{4r^2} + \&c.$  Q. E. I.

### SCHOLIUM.

And if we divide the Series (*Examp. I.*) by  $\sqrt{rr - xx}^{\frac{1}{2}}$  reduced to an infinite Series, and multiply the Divisor by the Quotient, we shall have  $rx - \frac{x^3}{6r} - \frac{x^5}{40r^3} - \frac{x^7}{112r^5} - \frac{5x^9}{1152r^7} - \&c. = x + \frac{2x^3}{6r^2} + \frac{32x^5}{123r^4} - \&c. \sqrt{rr - xx}^{\frac{1}{2}}$

And in general, If the given Fluxion consists of Universal Exponents and Co-efficients, reduce the Part under the *Vinculum* to an infinite Series, which multiply by the Part before the *Vinculum*, and find the flowing Quantity of every Term. Lastly, divide this last Series or the Fluent by the Part under the radical Sign affected, with any the most convenient Exponent, and multiply the said Part under the said Exponent by the said Quotient; so shall you have a Series expressing the Fluent of the given Fluxion, and readily shewing when and whether the Series consists of a finite Number of Terms or not.

*The Fluent of a Fluxion involving surd Quantities, may be investigated after another manner, which is sometimes preferable by much to the former: The Principles of this Method are,*

1. Reduce the given Fluxion to its simplest Terms.

2. Assume a new Equation affected with indetermined Co-efficients; so that reducing the same to Fluxions, the Terms of this may be compared with those of the given Fluxion, in order to determine the unknown Co-efficients.

3. Having determined the assumed Co-efficients, substitute their respective Values in the assumed Equation, and you have the Fluent of the given Fluxion.

*Since this Method deserves the Reader's Consideration, I shall endeavour fully to explain the same; and that I may not be misunderstood, I shall begin with some easy Examples.*

### Example I.

Let it be required to find the Fluent of  $\dot{x} \sqrt{ax - aa}$ , the Fluxion reduced to its simplest Terms is  $\dot{x} \times \sqrt{ax - aa}^{\frac{1}{2}}$ . Now suppose the Fluent of this Fluxion to be  $A \times \sqrt{ax - aa}^{\frac{3}{2}}$ , then it is evident, that the Fluxion of this Fluent must be equal to the given Fluxion, i. e.  $\frac{3}{2} A \times \dot{x} \times \sqrt{ax - aa}^{\frac{1}{2}}$  is  $= \dot{x} \times \sqrt{ax - aa}^{\frac{1}{2}}$ . Therefore (dividing by  $\sqrt{ax - aa}^{\frac{1}{2}}$ )  $\frac{3}{2} A \times \dot{x} = \dot{x}$ , and  $A = \frac{2}{3}$ . Having thus found the true Value of the indeterminate Co-efficient  $A$  (*viz.*  $\frac{2}{3}$ ) in the assum'd Equation, substitute the same in Place of  $A$ , and then we have  $\frac{2}{3} \times \sqrt{ax - aa}^{\frac{3}{2}}$  or  $\frac{2ax - 2aa}{3}$   $\sqrt{ax - aa}$  equal to the Fluent of the given Fluxion.

### Example II.

To find the Fluent of  $\frac{r\dot{x} - x\dot{x}}{\sqrt{2rx - xx}}$ , this Fluxion is expressed thus,  $\frac{r\dot{x} - x\dot{x}}{\sqrt{2rx - xx}} \times \sqrt{2rx - xx}^{\frac{1}{2}}$ . Suppose the Fluent thereof to be  $A \times \sqrt{2rx - xx}^{\frac{3}{2}}$ . Then the Fluxion of this Quantity is  $\frac{3}{2} A \times \frac{r\dot{x} - 2x\dot{x}}{\sqrt{2rx - xx}} \times \sqrt{2rx - xx}^{\frac{1}{2}}$ : Therefore  $\frac{3}{2} A \times r\dot{x} - 2x\dot{x} = r\dot{x} - x\dot{x}$ , and  $A = 1$ ; and consequently, the Fluent of the given Fluxion is equal to  $\sqrt{2rx - xx}^{\frac{3}{2}}$ .

### Example



## Example III.

To find the Fluent of  $d x^r \dot{x} \times \overline{e + f x^n}^m$ . Assume an Equation with indeterminate Co-efficients, so that reducing the same to Fluxions, the

Terms thereof may be compared with those of the given Fluxion. Let the said Equation be

$$A d x^{r-n+1} + B d x^{r-2n+1} + C d x^{r-3n+1}, \&c. \times \overline{e + f x^n}^{m+1} = S : d x^r \dot{x} \times \overline{e + f x^n}^m$$

Then,

$$\overline{r-n+1} \times A d x^{r-n} \dot{x} + \overline{r-2n+1} \times B d x^{r-2n} \dot{x} + \overline{r-3n+1} \times C d x^{r-3n} \dot{x}, \&c. \times \overline{e + f x^n}^{m+1} + \overline{m+1} \times \overline{e + f x^n}^m \times n f x^{n-1} \dot{x} \times A d x^{r-n+1} + B d x^{r-2n+1} + C d x^{r-3n+1}, \&c. = d x^r \dot{x} \times \overline{e + f x^n}^m.$$

Whence, supposing  $\frac{1}{p} = m+1$ , and putting  $\dot{x} = 1$ .

$$\overline{r-n+1} \times A d x^{r-n} + \overline{r-2n+1} \times B d x^{r-2n} + \overline{r-3n+1} \times C d x^{r-3n}, \&c. \times \overline{e + f x^n}^{\frac{1}{p}} + \frac{1}{p} \times n \times A d f x^r + \frac{1}{p} \times n \times B d f x^{r-n} + \frac{1}{p} \times n \times C d f x^{r-2n}, \&c. \times \overline{e + f x^n}^{\frac{1-p}{p}} = d x^r \times \overline{e + f x^n}^{\frac{1-p}{p}}.$$

And multiplying each Side of the Equation by  $p \times \overline{e + f x^n}^{\frac{p-1}{p}}$  we have  $p \times \overline{r-n+1} \times A d x^{r-n} + p \times \overline{r-2n+1} \times B d x^{r-2n} + p \times \overline{r-3n+1} \times C d x^{r-3n}, \&c. \times \overline{e + f x^n}^{\frac{1-p}{p}} + n \times A d f x^r + n \times B d f x^{r-n} + n \times C d f x^{r-2n}, \&c. = d x^r \times \overline{e + f x^n}^{\frac{1-p}{p}} \times p \times \overline{e + f x^n}^{\frac{p-1}{p}}$

Which being order'd, we have

$$\left. \begin{array}{l} p \times \overline{r-n+1} \times A d f \\ n \times A d f \end{array} \right\} x^r + \left. \begin{array}{l} p \times \overline{r-2n+1} \times A d e \\ p \times \overline{r-2n+1} \times B d f \end{array} \right\} x^{r-n} + \left. \begin{array}{l} p \times \overline{r-2n+1} \times B d e \\ p \times \overline{r-3n+1} \times C d f \end{array} \right\} x^{r-2n}, \&c. \\ + \quad + \quad + \quad n \times B d f \quad + \quad n \times C f$$

$$= d x^r \times \overline{e + f x^n}^{\frac{1-p}{p}} \times p \times \overline{e + f x^n}^{\frac{p-1}{p}} = p \times d x^r.$$

From which Equation the unknown Co-efficient  $A, B, C, \&c.$  may be determined in this manner;

$$p \times \overline{r-n+1} \times A d f + n \times A d f = p d.$$

And dividing by  $p d$ ,

$$\overline{r-n+1} \times A f + \frac{1}{p} \times n \times A f = 1,$$

Substituting  $m+1$  for  $\frac{1}{p}$ ,

$$\overline{r-n+1} \times A f + \overline{m+1} \times n \times A f = 1.$$

$$\text{Whence } A = \frac{1}{\overline{r-n+1} \times f + \overline{m+1} \times n \times f} = \frac{1}{m n + r + 1 \times f}$$

Secondly,

$$p \times \overline{r-n+1} \times A d e + p \times \overline{r-2n+1} \times B d f + n \times B d f = 0.$$

And by Transposition, Division and Restitution,

$$\overline{r-2n+1} \times B f + \overline{m+1} \times n \times B f = \overline{n-r-1} \times A e.$$

$$\text{Whence } B = \frac{\overline{n-r-1} \times A e}{\overline{r-2n+1} \times f + \overline{m+1} \times n \times f} = \frac{\overline{n-r-1} \times A e}{m n + r - n + 1 \times f}$$

In like manner,

$$C = \frac{\overline{2n-r-1} \times B e}{m n + r - 2n + 1 \times f}.$$

Whence



Whence it is evident that  $A dx^{r-n+1} + B dx^{r-2n+1} + C dx^{r-3n+1}, \&c.$   
 $\frac{d}{dx} \sqrt[m]{e + f x^n}$  is  $= \frac{d}{mn+r+1 \times f} \times x^{r-n+1} + \frac{d}{mn+r+1 \times f} \times \frac{n-r-1 \times e}{mn+r-n+1 \times f}$   
 $\times x^{r-2n+1} + \frac{d}{mn+r+1 \times f} \times x^{r-n+1} \times \frac{n-r-1 \times de}{mn+r-n+1 \times f} \times$   
 $\frac{2n-r-1 \times de}{mn+r-2n+1 \times f} \times x^{r-3n+1}, \&c. \times \sqrt[m]{e + f x^n} = S : dx \times \sqrt[m]{e + f x^n}, Q. E. I.$

In which it may be observed, That the Exponents of the Terms of the Indeterminate Series before the Radical Sign may be taken different from those above, provided that the Exponent of the first Term be not less than  $r - n + 1$ , and that the following Exponents proceed regularly: That the Exponents of the Terms before the Radical Sign may be continually increased or decreased by  $n$ ; for in either Case the Terms of the Fluxion of this assumed Equation will become homologous to those of the given Fluxion: That when the Exponents increase regularly by  $n$ , the Fluent will consist of a

finite Number of Terms, when  $\frac{r+1+mn}{-n}$  is equal to a positive whole Number: And that when the Exponents decrease regularly by  $n$ , the Fluent

$$\frac{d}{mn+r+1 \times f} \times x^{r-n+1} + \frac{d}{mn+r+1 \times f} \times \frac{n-r-1 \times de}{mn+r-n+1 \times f} \times x^{r-2n+1} +$$

$$\frac{d}{mn+r+1 \times f} \times \frac{n-r-1 \times de}{mn+r-n+1 \times f} \times \frac{2n-r-1 \times de}{mn+r-2n+1 \times f} \times x^{r-3n+1} + \&c. \times$$

$$\sqrt[m]{e + f x^n} = \frac{a}{\frac{1}{2} + 1 \times a} \times x^{0-1+1} \times \sqrt{\frac{1}{2} + 1 \times a} = \frac{2}{3} \times \sqrt{ax - aa} = S : a \sqrt{ax - aa}.$$

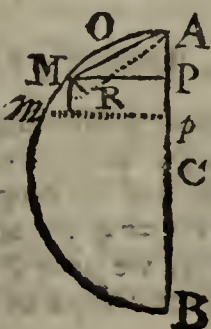
Q. E. I.

I have hitherto explained the General Methods of finding the Fluent of any Fluxion by help of Series's, and therefore shall not farther insist on these or other Methods invented for the same Purpose, but refer the Reader (who desires to have a fuller Account of them) to a late learned Treatise, writ by that excellent Analyst G. Cheyne, M. D. and entitled Fluxionum Methodus Inversa.

Since the Business of Infinite Series is sometimes tedious and too perplex'd, several other particular Methods have been invented to find the flowing Quantity of a Fluxion. It shall suffice, in this Place, to give the Reader an Idea of them, which will become more plain and familiar by several other Examples, to be seen in their proper Places.

#### Example I.

Let it be required to find the Flowing Quantity of  $\sqrt{2rx - xx}$ . On the Center C, with



will consist of a finite Number of Terms; when  $\frac{r+1}{n}$  is equal to a positive whole Number.

This General Theorem may easily be applied to find the Fluent of any given Fluxion included in the General one  $d x' \times \sqrt[m]{e + f x^n}$ . V. G.

To find the Fluent of  $a \dot{x} \times \sqrt{\frac{1}{2} + 1 \times a}$ . I put the same equal to the General Fluxion, viz.

$$d x' \times \sqrt{\frac{1}{2} + 1 \times a} = a \dot{x} \times \sqrt{\frac{1}{2} + 1 \times a}.$$

Then  $d = a$ ,  $f = 0$ ,  $f = a$ ,  $n = 1$ ,  $m = \frac{1}{2}$ ,  $e = -aa$ ; and if we substitute the said particular Values of  $d$ ,  $r$ ,  $f$ ,  $n$ ,  $m$ ,  $e$  in the General Fluent, we shall have

the Radius  $CB = r$ , describe the Semi-circle  $AMB$ , and suppose  $AP = x$ ; then is  $PB = 2r - x$ , and  $MP = \sqrt{2rx - xx}$ , and  $Pp = \dot{x}$ ; therefore the Fluxion of the Area, viz. the Parallelogram  $Mp$  is  $= \dot{x} \sqrt{2rx - xx}$ , and consequently the Sum of all the  $\dot{x} \sqrt{2rx - xx}$ , that is, the Flowing Quantity of the given Fluxion is equal to the Semi-segment  $AMP$ .

#### Example II.

Let it be required to find the Flowing Quantity of  $\frac{rx \dot{x}}{2 \sqrt{2rx - xx}}$ . Draw the Lines  $AM$ ,  $Am$ ,

infinitely near each other,  $MP$ ,  $mp$ , perpendicular to the Diameter  $AB$ , and  $MR$  perpendicular to  $Am$ ; then by the Property of the Circle  $AM =$

$\sqrt{2rx}$ , and  $Rm$  the Fluxion thereof is  $\frac{r \dot{x}}{\sqrt{2rx}}$ .

Now because the Triangles  $APM$ ,  $MRm$ , are (the Angles  $AMP$  and  $MmR$  standing on equal Arches of the Circle) similar, it is  $PM$

$$(\sqrt{2rx - xx}) : AP (x) :: Rm \left( \frac{r \dot{x}}{\sqrt{2rx}} \right) : MR$$

$$= \frac{rx \dot{x}}{\sqrt{2rx} \times \sqrt{2rx - xx}}; \text{ and consequently the}$$

infinitely little Sector  $MAR = \frac{1}{2} AR \times MR$  is  $=$

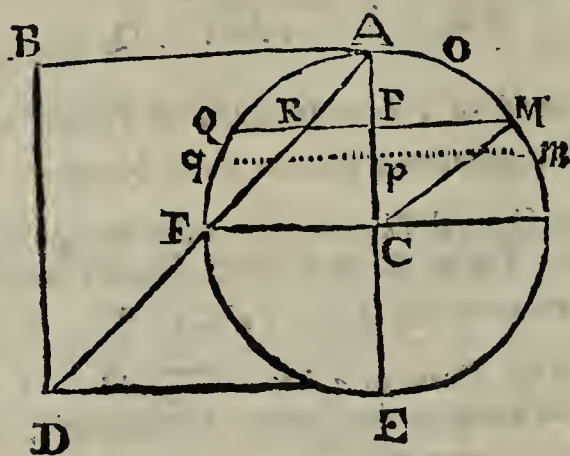
$$\frac{rx \dot{x}}{2 \sqrt{2rx - xx}} = \text{to the given Fluxion: Whence}$$



it is evident that the Segment  $AOMA$  is the flowing Quantity of the given Fluxion.

### Example III.

Let it be required to find the flowing Quantity of this Fluxion  $x \dot{x} \times 2 \sqrt{2rx - xx}$ . On the



Center C, with the Radius  $CA = r$ , describe the Circle  $AFEM$ ; and suppose  $AP = x$ ,  $Pp = \dot{x}$ ,  $PE = 2r - x$ , the Circumference  $AFEM = c$ ; then, I say, that the Sum of all the  $x \dot{x} \times 2 \sqrt{2rx - xx}$  is  $= \frac{crr}{2}$ .

### Demonstration.

Let the Circle  $AFEM$  be the Base of an upright Cylinder, and the Parallelogram  $ABDE$  the Section of the Cylinder thro' its Axis,  $AB$  the Height of the Cylinder is equal to  $AE$  the Diameter of the Base. Draw the Diagonal  $AD$ , then a Plane passing thro'  $AD$ , and perpendicular to the Plane  $BE$ , will divide the Cylinder in two equal Parts, and cut off the Semi-quadrantal Ungula  $ADE$ . Now the Fluxion of this Ungula is equal to the Parallelogram  $Qm$ , multiplied into its Height  $PR$  or  $AP$  (because the Angle  $RAP$  is equal to  $45^\circ$ )  $= x \dot{x} \times 2 \sqrt{2rx - xx}$ ; and consequently the Sum of all the  $x \dot{x} \times 2 \sqrt{2rx - xx}$  is (when  $AP$  becomes equal to  $AE$ , or  $x = 2r$ ) equal to the Semi-quadrantal Ungula  $ADE = \frac{crr}{2}$ . Q. E. I.

And thus innumerable Instances might be assign'd, to assist us in finding the flowing Quantity of any Fluxion, without having immediate Recourse to an Infinite Series.

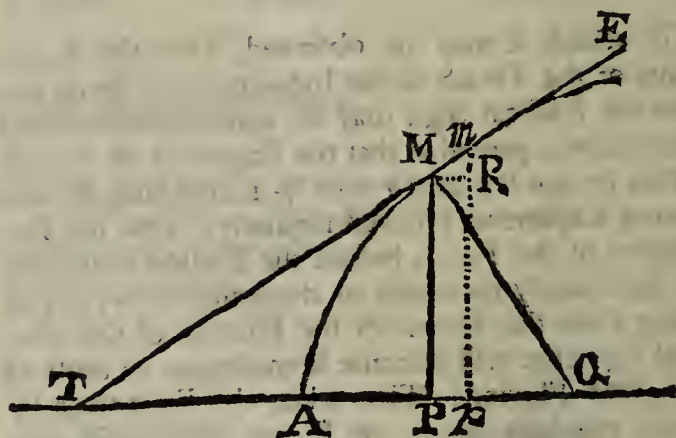
INVERSE Method of Tangents, is the Method of finding an Equation to express the Nature of a Curve in an Equation, express'd in the nearest Terms. This depends on the Problem of finding the fluent or flowing Quantity, by having the Fluxion given (of which see the Inverse Method of Fluxions above given.) And the Art of doing it Mr. Hayes (in Fluxions, p. 48.) shews after this manner.

At Page 33. he had shewn how to deduce Universal Rules for drawing Tangents to all Sorts of Geometrical Curves, when the given Equation expresses the Relation between the Ordinate and the intercepted Diameter. And therefore he states his 16th Proposition thus:

An Equation expressing the Value of the Sub-tangent of any Curve, in the nearest Terms being given: 'Tis requir'd to find the Equation expressing the Nature of the Curve.

1. What I mean by the nearest Terms will be best explain'd by an Example.

Suppose  $PT = t$ ,  $AP = x$ ,  $PM = y$ ,  $MT = s$ ; and let the Equation expressing the Nature of the



Curve be  $y^3 + ayy = x^3 + bxx$ ; then the Sub-tangent  $TP$  will be  $t = (\text{Hayes, Sect. 10. Art. 61.}) \frac{3y^3 + 2a.yy}{3xx + 2bx}$ . Now I call these Terms, expressing the Value of the Sub-tangent, the nearest, because they immediately flow from the Equation of the Curve: But if this Value of the Sub-tangent be changed, by applying the Equation of the Curve; v.g. If we put  $3y^3 = 3x^3 + 3bxx - 3a.yy$ ; and consequently  $t = \frac{3x^3 + 3bxx - a.yy}{3xx + 2bx}$ , such I call Remote Terms.

Now if the Value of the Sub-tangent be express'd in the nearest Terms, the Equation of the Curve may be investigated in this manner.

Let the Curve (Hayes, Fig. Art. 77.)  $AMm$  be described, and draw  $MT$  to touch the Curve in  $M$ ; then suppose the Abscissa  $AP = x$ ; the Ordinate  $PM = y$ ,  $Pp = \dot{x}$ ,  $Rm = \dot{y}$ ; then because the Triangles  $mRM$ ,  $MPT$  are similar; therefore

$$mR(\dot{y}) : RM(\dot{x}) :: PM(y) : PT = \frac{y\dot{x}}{\dot{y}}. \text{ Put}$$

this Value of the Sub-tangent equal to its Value given in the nearest Terms; clear the Equation of the Fractions, and find the flowing Quantity of each Term; so have you the Equation of the Curve.

### Example I.

Let it be required to find the Equation of the Curve  $AMm$ , the Value of the Sub-tangent  $PT$  being  $= \frac{2y^3}{3rr}$ . The Subtangent  $PT$  is  $= \frac{y\dot{x}}{\dot{y}}$

$$= (\text{ex Hyp.}) \frac{2y^3}{3rr}; \text{ therefore } 3rr y \dot{x} = 2y^3 \dot{y}, \text{ and}$$

$3rr \dot{x} = 2y^2 \dot{y}$ : And substituting  $x$  for  $\dot{x}$ , and  $y$  for  $\dot{y}$ :  $3rrx \square 2y^3$ , and (dividing  $3rrx$  by 1 the Exponent of  $x$ , and dividing  $2y^3$  by 3 the Exponent of  $y$ )  $3rrx = \frac{2}{3}y^3$ , and  $9rrx = 2y^3$ ; which divided by 2, we have  $\frac{9}{2}rrx = y^3$ , the Equation expressing the Nature of the Curve  $AMm$ .

Example



## Example II.

Let it be required to find the Property of the Curve  $AMm$ , the Sub-tangent  $PT$  being  $= \frac{2yy}{r}$

The Sub-tangent  $PT$  is  $= \frac{y\dot{x}}{\dot{y}} =$  (by Supposition)  $\frac{2yy}{r}$ ; and therefore  $ry\dot{x} = 2yy\dot{y}$ , and  $r\dot{x} = 2y\dot{y}$ , and (substituting  $x$  for  $\dot{x}$ , and  $y$  for  $\dot{y}$ )  $rx = 2yy$ , and consequently (dividing  $rx$  by the Exponent of  $x$ , and  $2yy$  by 2 the Exponent of  $y$ )  $rx = yy$ , which shews that the Curve  $AMm$  is a Parabola.

## Example III.

Let it be required to find the Property of the Curve  $AMm$ , the Value of the Sub-tangent  $PT$  being  $= \frac{3y^3 + 2byy}{3xx + 2ax}$ .

The Sub-tangent  $PT$  is  $= \frac{y\dot{x}}{\dot{y}} = \frac{3y^3 + 2byy}{3xx + 2ax}$ . Therefore  $3xx\dot{x} + 2ax\dot{x} = 3y^2\dot{y} + 2by\dot{y}$ , and (putting  $x$  for  $\dot{x}$ , and  $y$  for  $\dot{y}$ )  $3x^3 + 2ax^2 = 3y^3 + 2by^2$ , and (dividing every Term by the Exponent of the flowing Quantity therein)  $x^3 + axx = y^3 + byy$ ; which Equation expresses the Nature of the Curve  $AMm$ .

But because this Method depends on that *Problem*, to find the flowing Quantity of any Fluxions, with which the Reader is yet supposed to be unacquainted, I shall desist from prosecuting the same any further at present, and content myself to deduce the Solution of the present *Proposition* from the (*Hayes*, Art. 61.) sixth preceding; this being nothing but the *Reverse* of that.

That we may be able to proceed with the greater Certainty in this Enquiry, it will be necessary to observe from the forecited Place:

1. The Sub-tangent  $t$  is always of one Dimension, and is express'd by a Fraction.

2. When the Value of the Sub-tangent is expressed in the nearest Terms, then the Numerator of the Fraction consists only of those Terms wherein the Ordinate  $y$  (or the Tangent  $s$ ) is found.

3. And if all the Terms of the Equation of the Curve be simple Terms, then the intercepted Diameter  $x$  never occurs in the Numerator; nor the Ordinate  $y$ , Tangent  $s$ , or Curve  $z$ , in the Denominator.

4. But if the Equation of the Curve contain mix'd Terms, then both  $x$ ,  $z$ ,  $s$  and  $y$  may be found in both Parts of the Fraction; but with this Condition, that the Fraction being reduced to an Equation, and all the Terms of the Equation being brought over to one Side, and every  $t$  changed into  $x$ , and every  $s$  into  $z$ , every mix'd Term will be found as often as there are variable Quantities in the same. And the Coefficients, or prefixed Numbers, will be equal or proportional to the respective Exponents of the Powers of the variable Quantities.

5. Whence it follows, that the Signs of the Terms, wherein the same variable Quantities occur, are the same, after a due Division by the prefix'd Numbers (or rather by the Exponents of the variable Quantities).

Hence to resolve the *Problem* concerning the

*Inverse Method of Tangents.*

1. Change every  $t$  into  $x$ , and every  $s$  into  $z$  (denoting the Curve) and transpose all the Terms to one Side of the Equation, and diligently observe whether all the Terms are simple, or some simple and others mix'd.

2. If all the Terms be simple, divide every Term by the Exponent of the intermediate or flowing Quantity in the same; so have you the Equation expressing the Nature of the Curve.

3. And if there be any mix'd Terms, then observe (*Hayes*, Sect. 4, 5. Art. 78.) and let every Term containing the same variable Quantities be divided by the Exponent of the Power to which the respective flowing Quantities are advanced, so that the same Term result from every such Division, and be as often found in the Equation as it has flowing Quantities.

4. Retain only one of those mix'd Terms which occur more than once in the Equation, and manage the other simple Terms according to *Hayes*, Sect. 2. and there will arise an Equation expressing the Nature of the Curve.

## Example I.

Suppose  $t = \frac{y^3 + ayy - bby}{xx + ax + bb}$  then (by Rule 1.)

changing  $t$  into  $x$ , and transposing all the Terms to one Side of the Equation, we have  $x^3 + axx + bby - y^3 - ayy + bby$ ; and because all the Terms are simple Terms, therefore (2.)  $\frac{1}{3}x + \frac{1}{2}axx + bby - \frac{1}{3}y^3 - \frac{1}{2}ayy + bby = 0$ , which is an Equation expressing the Nature of the Curve, as was required.

## Example II.

Let the Value of the Sub-tangent be  $t = \frac{3y^3 + 2ayy - 2xyy - xxy}{3xx + 2xy + yy}$ , then we have (by

1.)  $3x^3 + 2yxx + yyx - 3y^3 - 2ayy + 2xyy + xxy$ ; and because we have the mix'd Terms  $2yxx$  and  $yxx$ , also  $yyx$  and  $2yyx$ , each repeated twice, according to the Number of the flowing Quantities; therefore if one of them be divided by the Exponent of  $x$ , and the other by the Exponent of  $y$ , (3.) there will arise  $yxx + yyx$  (by 4.) and dividing the simple Terms by the Exponents of the flowing Quantities in each respectively, the Equation expressing the Nature of the Curve will be  $x^3 + yxx + yyx - y^3 - ayy = 0$ .

## Example III.

And the Method is the same if the Curve  $z$  enter into the Value of the Sub-tangent; v.g. suppose  $t = \frac{6ay^3zz + 4ay^3zs + aay^4 - yxxz^3 - 3yxxzzs}{2yxxz^3}$

change every  $t$  into  $x$ , and every  $s$  into  $z$ ; and transpose all the Terms over to the same Side of the Equation, and then we have  $2y^3\dot{x}x + yxxz^3 + 3yxxz^3 - 6ay^3zz - 4ay^3zs - aay^4$ .

Wherein the Term  $yxxz^3$ , containing three flowing Quantities, is found thrice, and the Term  $ay^3zz$ , containing two, is found twice: And because those mix'd Terms being divided by the respective Exponents of the Powers of the flowing Quantities, the same Quotient always results; it is plain that the Value of the Sub-tangent is given in the nearest Terms; and therefore the Equation expressing



pressing the Nature of the Curve will be  $yz^3x^2 - 2ay^3zz - \frac{1}{4}aay^4 = 0$ : Or adding any determinate Quantity  $bb$ ;  $yz^3x^2 - 2ay^3zz - \frac{1}{4}aay^4 + bb = 0$ .

Hence it appears that a determinate Quantity may be added to the Equation of the Curve; which is plain from the direct Method of Tangents; because then when we investigate the Value of the Sub-rangent, all the Terms consisting of invariable Quantities are rejected and vanish: And this is sometimes absolutely necessary; v. g. Suppose  $t = \frac{-xy}{2x+y}$ : then we have  $2xx + yx + xy$ ; and consequently  $xx + xy = 0$ : And because this Equation has no true Root, therefore we must add a determinate Quantity, and then the Equation of the Curve may be  $xx + xy = bb$ .

### COROLLARY.

Hence, if the Value of the Subnormal (Fig. Hayes, Art. 82.)  $PQ$  be given, the Property of the Curve may be found. For the Triangles  $QMP$ ,  $MTP$  are similar; therefore  $QP:PM::PM:PT$ ; and if  $PQ$  be  $= q$ , then  $t = \frac{yy}{q}$ . Whence the Equation of the Curve may easily be (Hayes, Art. 78, 79.) found.

The Property of the Curve may be investigated otherwise, thus: The Triangles  $mRM$ ,  $QPM$ , are similar; therefore  $MR(\dot{x}):Rm(\dot{y})::PM(y):PQ = \frac{yy}{x}$ , and putting this equal to the Value of the Subnormal given, the Property of the Curve may be (Hayes, Art. 77.) found.

### Example.

Suppose  $PQ = \frac{aax}{2yy}$ ; then is  $\frac{y\dot{y}}{x} = \frac{aax}{2yy}$ , and  $aax\dot{x} = 2y^3\dot{y}$ ; and (substituting  $x$  for  $\dot{x}$ , and  $y$  for  $\dot{y}$ )  $aaxx \square 2y^4$ ; therefore (dividing the Terms by the Exponents of  $x$  and  $y$  respectively)  $\frac{1}{2}aaxx = \frac{1}{2}y^4$ . Whence  $ax = y^2$ ; which shews that the Curve  $AMm$  is a *Parabola*.

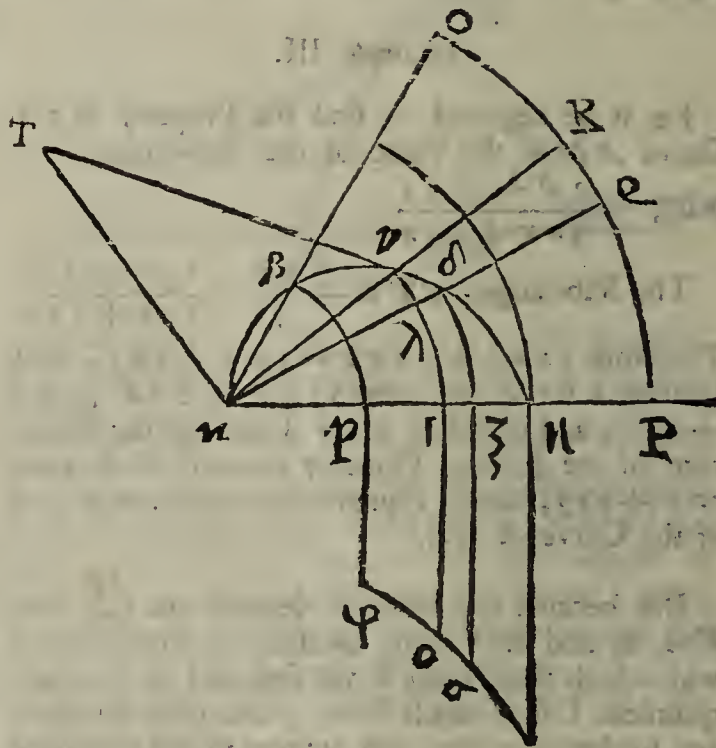
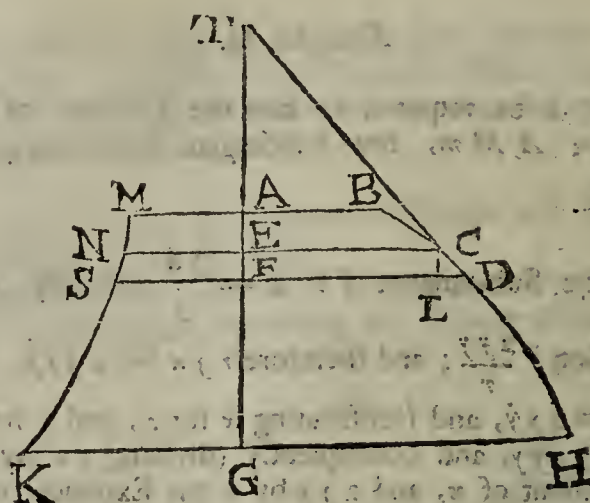
INVEST. To *Invest*, in the Law, signifies to give Possession: And the Action of doing this, which is attended in different Places with different Ceremonies, Forms and Customs, is called

INVESTITURE, a giving of, or putting into the Possession of.

To INVEST [in the Art of War] is to open the Siege of a Place, and to encamp an Army round it, to block up all its Avenues, and to prevent both Ingrefs and Egreffs.

INVOLUCRUM Cordis: see *Pericardium*.

INVOLUTE and Evolute Figures, in Mathematicks, are such as these:



Let the Space  $ABHG$  be divided into an infinite Number of Trapezia; and imagine the Portions of the Curve  $CD$ , and their Sines  $CL$ , to be flexible like so many Threads; and the Ordinates  $AB$ ,  $EC$ ,  $FD$ ,  $GH$ , to be rigid and inflexible: Then the Trapezia  $CEFD$  may be changed into the trilineal Figures  $x\gamma\delta$ ; viz. if the Points  $E$  and  $F$  be supposed to co-incide; and if this be done in all the other Trapezia's, and if all the Points of the Divisions in the Axis be supposed to be contracted or meet in  $G$ , there will be produced a new Figure  $x\beta n$ ; and the Point  $x$  will represent the Point of Concourse, wherein all the Points of the Axis  $A$ ,  $E$ ,  $F$ ,  $G$ , &c. meet; and the Figure  $x\beta n$  is called the *Involuta* of the Figure  $ABHG$ , and this is call'd the *Evoluta* of that. Now the Properties of these Figures are,

1. Because the Rectangle  $CLFE$  is supposed to be chang'd into the infinitely little Sector of a Circle  $\gamma x \lambda$ , this Sector is equal to half that Parallelogram, the Angles at  $\gamma$  and  $\lambda$  being Right Angles, and  $\lambda\gamma$  being  $= CL$ ; and if this be observed in all the rest, all the Rectangles  $CEFL$ , or the Figure  $ABHG$ , is equal to twice the Sum of all the Triangles  $x\gamma\lambda$ , or the *Involuta*  $x\beta n$ .

2. Because, by Supposition,  $CL = \gamma\lambda$ , and  $CD = \gamma\delta$ , and the Angles  $L$  and  $\lambda$  Right Angles; therefore the Triangles  $CLD$  and  $\gamma\lambda\delta$  are similar and equal: Whence, if we suppose the Angle  $Tx\gamma = \gamma\lambda\delta$ , then the Triangles  $Tx\gamma$  and  $TEC$  will be (because  $\gamma x = EC$ ) similar and equal.

3. The Arch  $\beta p$  describ'd with the Radius  $x\beta$ , is less than the Axis  $AG$ , and the Axis  $n\mu$  describ'd



bed with the Radius  $xn$ , is greater than the said Axis  $AG$ , as is evident from the Genesis of these Figures. See *Hayes's Fluxions*, p. 109.

INVOLUTION, in *Algebra*, is the raising or producing of Powers from any proposed Root; and is performed in all Respects like Multiplication, save only in this; Multiplication admits of any different Factors, but Involution still retains the same; and Products made by the continual Multiplication of the same Quantity or Factors are Positive Powers; but the Quotients of an Unit divided by any Power of the same Quantity, are Negative Powers.

Thus  $x, x^2, x^3, x^4, \&c.$  are positive Powers of  $x$ ; but  $x^{\frac{1}{2}}, x^{\frac{1}{3}}, x^{\frac{1}{4}}, \&c.$  are negative Powers of  $x$ , and are to be expressed thus,  $x^{-1}, x^{-2}, x^{-3}, x^{-4}, \&c.$  with negative Exponents.

Supposing that any Root is the first Power of itself, or that the first Power arises when the Root is multiplied into Unity: If then the same Root be multiplied into itself, it produces its Square or second Power; and if the Root be multiplied into its Square, it will produce its Cube or third Power; and the Root multiplied into its Cube produces the Biquadrate or fourth Power,  $\&c.$  The Exponents of those Powers are 1, 2, 3, 4, 5,  $\&c.$  according to the Number of Dimensions of which they are compounded; or universally, the Exponents may be represented by Letters,  $x, x^2, x^3, x^4, = x, x^m, x^n, \&c.$

Powers are not only produced from the Root itself, multiplied into the Degree next going before, but also from the mutual Multiplication of the inferior Powers, as their very Names declare: For Example; the Biquadrate arises not only from the Root multiplied into the Cube, but also from the Square multiplied into itself; whence this Power (*i.e.* the fourth) is also a Square; and the like you may judge of the rest. Every Root is either (1.) Simple, that is, of one Name, as  $a, 2a, 3a, \&c.$  for the Numbers set before the Letters do not increase the Names; or (2.) Compound, or of more Names, that is, Binomials, Trinomials,  $\&c.$  as  $a+x$ , or  $x-y$ ,  $x+y+z$ ,  $x-y+z$ ,  $x+y-z$ ,  $x-y-z$ .

Moreover, every Root is either rational, as  $x, 2x, \frac{1}{2}x$ ; or irrational, as  $\sqrt{x}, \sqrt{xa}, \sqrt[3]{xy}$ ; and as the Roots are, such also are their Powers; but in this Place we shall treat only of those that are rational.

The Genesis of Powers from a simple Root are thus performed: If the Root be a Side (or first Power) let there be annexed to it a simple Number or Letter, such as agrees to the Nature of that Power, and placed above to the Right Hand, as in the Index of the Multiplication: As if the Root be  $x$ , its Square will be  $x^2$ , Cube  $x^3$ ,  $\&c.$  If the Root have a Co-efficient, it is to be raised with the Root to the Power required.

Thus, Let the Root be  $3xy$ .

Its Square is  $9x^2y^2$ .

Its Cube  $27x^3y^3$ .

Its Biquadrate or fourth Power  $81x^4y^4$ .

Any Powers (of the same Quantity) whether positive or negative, are multiplied into one another by the Addition of the Exponents. Thus,

$$x^3 \times x^5 = x^8; a^4 \times a^2 = a^6; x^{\frac{3}{2}} \times x^{\frac{5}{2}} = x^4 \\ x^{-2} \times x^{-3} = x^{-5}; a^{-1} \times a^{-2} = a^{-3}$$

The Division of Powers is done by the Subtraction of the Exponents. Thus,

$$x^7 \div x^5 = x^2; a^8 \div a^3 = a^5 \\ x^{-6} \div x^{-4} = x^{-2}$$

The Raising of Powers to other Powers is done by multiplying the Exponents. Or, thus; if any given Power is to be raised to another given Power, the Index of the Power proposed must be multiplied into the Index of that Power, to which the first ought to be raised. So  $x^5$  raised to the third Power, is  $x^5 \times 3 = x^{15}$ .

The Involution of any Binominal or Quantity, consisting only of two Terms, as  $x+y$ , may be performed by the following Rules, the first of which discovers the Indices of the Powers required, and the other the Co-efficients.

When any Binominal, as  $x+y$ , is to be raised to any Power, as  $m$ , the Quantities that compose that Power will be  $x^m, x^{m-1}y, x^{m-2}y^2, x^{m-3}y^3, x^{m-4}y^4, \&c.$  continuing this Series till the Exponent of  $y$  becomes equal to  $m$ ; in which Series you see the Exponent of  $x$  is diminished always by Unit in every Term, from what it was in the preceding Term, while the Exponent of  $y$  is constantly increased by Unit, above what it was in the preceding Term. Thus let  $m=7$ , that is, let  $x+y$  be raised to the seventh Power, and the Quantities that compose that Power will by the preceding Rule stand thus:

$$x^7 + x^6y + x^5y^2 + x^4y^3 + x^3y^4 + x^2y^5 + xy^6 + y^7.$$

In which the Indices of the Powers to the leading Quantity  $x$  continually decrease, and the Indices of the other Quantity do continually increase in an Arithmetical Progression, Unit being their common Difference. The first and last Terms are always pure Powers of the single Quantities, and are both of the same Height. The Sum of the Indices of any two Letters joined together in the intermediate Terms, are always equal to the Power required.

The Co-efficient of the first Term is always Unit; the Co-efficient of the second Term is  $=$  to Unit, multiplied into the Index of the Powers of the first Term, and that Product divided by Unit; the Co-efficient of the third Term is found by multiplying the Co-efficient of the second Term, into the Index of the leading Quantity of that Term, and that Product divided by 2: So the Co-efficient of any Term may be found by multiplying the Index of the leading Quantity of the preceding Term by its Co-efficient, and dividing that Product by the Number of Terms preceding the Term whose Co-efficient is required. Thus to find the Co-efficients of the several Terms of the seventh Power of  $x+y$ ,

The Co-efficient of the 1st Term is  $= 1$ .

of the 2d Term is  $\frac{1 \times 7}{1} = 7$ .

of the 3d Term is  $7 \times 6 \div 2 = 21$ .

of the 4th Term is  $21 \times 5 \div 3 = 35$ .

of the 5th Term is  $35 \times 4 \div 4 = 35$ .

of the 6th Term is  $35 \times 3 \div 5 = 21$ .

of the 7th Term is  $21 \times 2 \div 6 = 7$ .

of the last Term is  $7 \times 1 \div 7 = 1$ .

And if those Co-efficients be prefixed to the Quantities that make up the several Terms of the seventh Power, they will stand thus;  $x^7 + 7x^6y + 21x^5y^2 + 35x^4y^3 + 35x^3y^4 + 21x^2y^5 + 7xy^6 + y^7$ .

Now here it may be further observed, that the Unciæ (or Co-efficients) do only increase until the Indices of the two Letters become equal, or change Places; and the rest of the Unciæ will return or decrease in the same Order; that is, where-ever the Indices of the Letters are alike, there the Unciæ will be alike.



And therefore one needs to find the *Unciæ* (as before) but to half the Number of Terms in any Power.

The two preceding Rules may be universally applied. Thus, if  $m$  be equal to any whole Number, then the several Terms of the  $m$ th Power of  $x + y$  will be equal to  $x^m + m x^{m-1} y + m \times \frac{m-1}{2}$

$$x^{m-2} y^2 + m \times \frac{m-1}{2} \times \frac{m-2}{3} x^{m-3} y^3 + m \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4} x^{m-4} y^4 + \&c.$$

The Powers raised from a Residual Root, *viz.*  $x - y$  (the Difference of two Quantities) are the same with their like Powers raised from a Binomial Root  $x + y$  (or the Sum of two Quantities) save only in their Signs, *viz.* the Binomial Powers have the Sign  $+$  to every Term; but the Residual Powers have the Sign  $+$  and  $-$  interchangeably to every other Term.

Fractions are involved by multiplying the Numerator into itself for a new Numerator, and the Denominator into itself for a new Denominator; each so often as the Power requires.

$$\text{Thus the 3d Power of } \frac{x}{y} = \frac{x^3}{y^3}.$$

$$\text{The 3d Power of } \frac{2xa}{2yb} = \frac{27x^3a^3}{8y^3b^3}.$$

$$\text{The 3d Power of } \frac{x+y}{a-b} = \frac{x^3 + 3x^2y + 3xy^2 + y^3}{a^3 - 3a^2b + 3ab^2 - b^3}.$$

INVOYCE, 12 *Car.* 2. c. 34. is a Particular of the Value, Custom, and Charges of any Goods sent by a Merchant in another Man's Ship, and consign'd to a Factor or Correspondent in another Country.

INWARD *Flanking Angle*, in Fortification, is made by the Courtine and the *Razant Flanking-Line of Defence*.

JOBENT Nails, are a smaller Sort, commonly used to nail thin Plates of Iron to Wood.

JOINT Tenants, are such as come to, and hold Lands or Tenements by one Title *pro Indiviso*, or without Partition.

These are distinguish'd from *Sole* or *Several Tenants*; from *Parceners*, and from *Tenants in Common*: And anciently they were called *Participes*, and not *Heredes*: And these must *jointly implead*, and *jointly be impleaded*; which Property is common to them and to *Coparceners*. But *Joint-Tenants* have a *sole Property* of Survivorship, which *Coparceners* have not: For if there be two or three *Joint-Tenants*, and one hath Issue and dies, then he, or those *Joint-Tenants* that survive, shall have the whole by Survivorship.

JOINT, [*Junctura*, L. *Joint*, F.] a Juncture, Articulation, or Assemblage of two or more things.

JOINT, [in *Carpentry*] the several Manners of assembling or fitting Pieces of Wood together; as a Dove-tail Joint, &c.

JOINT [in *Architecture*] is the Separation between the Stones, which is fill'd with Mortar, Cement, or Plaster.

JOINTURE. See *Joynture*.

JOISTS, in *Architecture*, are such Pieces of Timber as are framed into the Girders and Summers, and on which the Boards of the Floor are laid.

IONIC, in *Architecture*, is the Name of one of the five Orders: The first Idea of it was given by the People of *Ionia*; who, according to *Vitruvius*,

form'd it on the Model of a young Woman dressed in her Hair, and of an easy, elegant Shape; whereas the *Doric* had been form'd on the Model of a strong, robust Man. The *Ionic* Column is the third in order, and is distinguished from the Composite, in that it has none of the Leaves of *Acanthus* in its Capital; and from the *Tuscan*, *Doric* and *Corinthian*, by the Volutes or Rams Horns, which adorn its Capital; and from the *Tuscan* and *Doric* too, by the Channels or Flutings in its Shaft. These Flutings are in Number 24; they are not always concave from the Top of the Shaft to the Bottom; but for that third of it next the Base, are fill'd up with a kind of Rods or Canes, by the *French* called *Batons*; and in the other two thirds, are left hollow or striated, in Imitation of the Folds or Plaits of a Garment. This Column is a Medium between the Massive and the Delicate Orders, the Simple and the Rich. Its Height is 18 Modules, or 9 Diameters of the Column taken at the Bottom. When it was first invented, its Height was but 16 Modules; but the Ancients, to render it still more beautiful than the *Doric*, augmented its Height, by adding a Base to it, which was unknown in the *Doric*. M. le Clerc makes its Entablement 4 Modules and 10 Minutes, and its Pedestal 6 entire Modules; so that the whole Order makes 28 Modules, 10 Minutes. 'Tis said the Temple of *Diana* at *Ephesus*, the most celebrated Edifice of all Antiquity, was of this Order. At present it is properly used in Churches and Religious Houses, in Courts of Justice, and other Places of Tranquillity and Devotion. This Order has one Advantage above any of the rest, and it consists in this, that the fore and hind Parts of its Capital are different from its Sides. But this is attended with an Inconvenience, when the Ordonnance is to turn from the Front of the Building to the Side; to obviate which, the Capital may be made angular, as is done in the Temple of *Fortuna Virilis*. Scamozzi, and some other modern Architects, have introduced the upper Part of the Composite Capital in lieu of the *Ionic*; imitating that of the Temple of *Concord*, whose four Sides are alike: To render it more beautiful, the Volute may be made a little oval and inclining.

JONTHUS, [*Ionoth*, Gr.] or *Varus*, is a little, hard, callous Swelling in the Skin of the Face. Blanchard.

JOURNAL [with *Navigators*] a Register kept, wherein particular Notice is taken of every thing that happens to the Ship from Day to Day, and from Hour to Hour, with respect to the Wind, the Rhumbs, Rake, Soundings, &c. in order to enable them to adjust their Reckoning, and determine the Place where they are.

JOURNEYS Accounts, is a Term in Law, to be thus understood: If a Writ be abated without the Default of the Plaintiff or Demandant, he may purchase a new Writ, which if it be purchased by *Journeys Accounts*; (that is, within as little Time as he possibly can after the Abatement of the first Writ) then this second Writ shall be as a Continuance of the first, and so shall out the Tenant or Defendant of his Voucher, Plea, or Non-tenure, Joint-tenancy fully administred, &c. or any other Plea which arises upon Matter happening after the Date of the first Writ; and 15 Days have been held a convenient Time for the Purchase of the new Writ.

JOY, is a Delight of the Mind, from the Consideration of the present, or assured approaching Possession of a Good; and we are then possessed of any Good, when we have it so in our Power that we can use it when we please.

JOYNDER,



JOYNDER, in *Law*, is the coupling or joining of two Persons in one Action or Suit against another.

JOYNTURE, is a Covenant, whereby the Husband, or some other Friend in his Behalf, assureth unto his Wife, in respect of Marriage, Lands or Tenements for a Term of Life: Or otherwise,

It is so called, either because granted *Ratione Juncturae in Matrimonio*; or because the Land in *Frank-Marriage* is given jointly to the Husband and Wife, and after to the Heirs of their Bodies, whereby the Husband and Wife be made joint Tenants during the Coverture.

JOYSTS. See *Joists*.

IRIS, [of *εἶς*, Gr. *to speak, to tell*; as being a Meteor that is suppos'd to foretel Rain] a Rainbow, occasion'd by a Reflection of the Rays of the Sun in a watry Cloud. Vide *Rainbow*.

IRIS, is that fibrous Circle next to the Pupil of the Eye, distinguished with Variety of Colours: see *Uvea Membrana*. 'Tis so called from its Similitude to a Rainbow (in Latin *Iris*).

Also those changeable Colours which sometimes appear in the Glasses of Telescopes, Microscopes, &c. are called *Iris* for the same Reason; as is that coloured *Spectrum*, which a Triangular Prismatick Glass will project on a Wall, when placed (at a due Angle) in the Sun-beams. See *Rainbow*.

IRON. In the Forest of *Dean* in *Gloucestershire* the best Iron Ore is of a bluish Colour, and is called *Brush Ore*: But this being melted alone produces a Metal very short and brittle: To remedy which Inconvenience they make use of *Cynder*, which is found in great Quantity where any old Works have been in that County: For in former Times, their Bellows being moved only by Hand, their Furnaces produced a Fire much less intense than those they now employ: So that formerly they melted down only the principal Part of the Ore, rejecting the rest as useless. This Refuse is the *Cynder*; which being mingled with the Ore in a due Quantity, gives it that excellent Temper of Toughness, for which this Iron is preferred before any brought from abroad.

The Ore is first calcined in Kilns, like ordinary Lime-Kilns, which they fill up to the Top with Coal and Ore, *S. S. S.* Then putting Fire to the Bottom, they let it burn till the Coal be wasted. This is done without *Fusion* of the Metal, and serves to consume the more drossy Part of the Ore, and to make it friable. From hence they carry it to the Furnaces, which are built of Brick or Stone, about 24 Foot square on the Outside, and near 30 Foot in Height. Within they are not above 8 or 10 Foot over in the middle, and the Top and Bottom have a yet narrower Compass; so they are almost of the Shape of an Egg. Behind the Furnace are placed two very large Pair of Bellows, whose Noses meet at a little Hole near the Bottom. These are compressed together by certain *Buttons* placed on the Axis of a very large *Overshot Wheel*.

The Furnaces are at first filled with Ore and *Cynder*, intermix'd with Fuel, which in these Works is always of Charcoal, laying them hollow at the Bottom, that they may the more easily take Fire. But after they are once kindled, the Materials run together into a hard Cake or Lump, which is sustained by the Fashion of the Furnace; and through this the Metal, as it melts, trickles down into the *Receivers*, where there is a Passage open, by which they clear away the Scum and Dross. Before this lies a great Bed of Sand, wherein they make Furrows of what Fashion they please, into which they

let their Metal; which is made so very fluent by the Violence of the Fire, that it continues boiling for a good while. The Furnaces are kept at work Day and Night for many Months, still supplying the Waste of the *Fuel* and other Materials with fresh, pour'd in at the Top.

From these Furnaces they bring their *Sows* and *Pigs* of *Irons* (as they call them) to their *Forges*. These *Forges* are of two Sorts, tho' standing together under the same Roof: And one they call *Finery*, the other their *Chafery*. Both of them are on Hearths, on which they place great Heaps of *Sea-Coal*, and behind them Bellows, like the former, but not near so large. Into their *Finery* they first put the *Pigs* of *Iron*, placing three or four of them together behind the Fire, with a little of one End thrust into it; where softning by degrees, they stir and work them with long Bars of *Iron*, till the Metal runs together into a round Mass or Lump, which they call an *Half-Bloom*. This they take out, and giving it a few Strokes with their *Sledges*, they carry it to a great weighty *Hammer*, raised by the Motion of a Water-Wheel; where applying it dextrously to the Blows, they presently beat it out into a thick short Square: This they put into the *Finery* again; and heating it red hot, they work it out under the same *Hammer*, till it comes to be in the Shape of a Bar in the middle, but with two square Knobs on the Ends. Last of all, they give it other Heats in the *Chafery*, and more Workings under the Hammer, till they have brought their *Iron* into Bars of several Shapes and Sizes. If they omit any one Process, it will be sure to want something of its *Toughness*, which they esteem its Perfection.

For the Backs of Chimneys, Hearths of Ovens, or the like, they take the melted Metal out of the *Receivers* in great Ladles, and pour it into Moulds of fine Sand. *Philos. Trans. N° 137.*

At *Milthorpe* in *Lancashire* they have several Sorts of *Iron-Stone*, some of it making *Coldshire-Iron*; that is, such as is brittle when it is cold. Another sort makes *Redshire*, which is such as is apt to break if it be hammer'd when 'tis of a dark red Heat; and therefore they are never melted down but in Mixture, and so they yield an indifferent good sort of *Iron*. They have of late made it much better than before, by melting the *Sow-Metal* over again, as likewise by using Turf and Charcoal; whereas formerly the Fuel was only Charcoal.

They first burn the *Iron-Stone*, and then for every seventeen Baskets of this burnt Stone they put in one of Lime-Stone, *unburnt*, to make it melt freely and cast the *Cynder*, which they always take off from the melted *Iron*, before they let it run.

The Bottom of the Furnace is about two Yards square, and so rises perpendicularly for a Yard or more, which is also lined within with a Wall of the best Fire-stone, to keep off the Force of the Fire from the Walls of the Furnace. The Bellows, which are very large, and moved by Water, enter about the middle of the *Focus*: The rest of the Furnace is raised above this six or seven Yards *squarewise*, but *tapering*; so that the top Hole, where they throw in the Mine and Fuel, is but half a Yard square. When they find it to have subsided about a Yard and Quarter, they fill the Furnace again.

Their *Forge* is much like that of a common Blacksmith's, about one Yard and half over, and of the same Height. The *Hearth* is all of *Sow-Iron*, much of the Shape of a broad-brim'd Hat, with the Crown downwards. The hollow Place they fill and heap up



up with Charcoal, and lay the Ore (first broken into Pieces as big as a Pigeon's Egg) all round about the Charcoal on the flat Hearth, to bake it as it were, or Neal it; thrusting it by little and little into the Hollow, and keep blowing for twelve Hours. Then they pull out a Stopple at the Bottom of the Wall, and out comes all the *Glassy Cynder*, being very liquid, leaving the *Iron*, which is never in a perfect Fusion, in a Lump at the Bottom: This they take out with great Tongs, and turn it under heavy Hammers moved by Water, which at the same time beat off, or rather squeeze out the fluid *Scoria* or Dross, and after several Heats form it into Bars. They use no Lime-Stone, or any thing else, to promote the Flux. They get about 100 Pound Weight of Metal at one *melting*, out of about three times as much Ore.

The *Iron Mine* in *Suffex* lies from four Foot deep to forty and upwards. There are several sorts of Mine, some hard, some gentle, some rich, some poor, some fine, some coarser. The *Iron Masters* mix different sorts of Mine together, otherwise it will not melt to so good an Advantage.

When the Mine is brought in, they take Small-coal, and lay a Row of that and a Row of Mine alternately, *S. S. S.* one above another; and setting the Coals on Fire, therewith burn the Ore. This is done to mollify it, that so it may be broken in small Pieces, otherwise it would not melt in the Furnace, but come away whole: Nor must it be over-burnt; for then it will *loop*, as they call it; that is, run together in a Mass.

After 'tis burnt, 'tis beat into small Pieces with an *Iron Sledge*, and then put into the Furnace, which is before charged with Coals, on the Top of which it is cast, where it melts and falls down into the *Hearth* in about twelve Hours more or less, and then 'tis run into a *Sow*.

This *Hearth* is made of Sand-Stone, as also its Sides round to the Height of about a Yard; and then the rest of the Furnace is lined up to the Top with Brick.

When they begin upon a new Furnace, they put Fire for a Day or two before they begin to blow: Then they blow gently, and increase by Degrees, till they come to the Height in ten Weeks or more.

Every six Days they call a *Founday*, in which time they make 8 Ton of *Iron*; that is, if you divide the whole Sum of *Iron* they make by the *Founday*; or at first they make less in a *Founday*, at last more.

The *Hearth*, by the Force of the Fire continually blown, grows wider and wider; so that if at first it contains so much as will make a *Sow* of 600 or 700 Pound Weight, at last it will contain so much as will make a *Sow* of 2000 Pound. The lesser Pieces of 1000 Pound, and under, they call *Pigs*.

Of twenty-four Load of Coals, they expect eight Ton of *Sows*. To every Load of Coals, which consists of eleven Quarters, they put a Load of Mine, containing eighteen Bushels.

A *Hearth*, if made of good Stone, will ordinarily last forty *Foundays* or Weeks; during which time the Fire is never let go out. They never blow twice on one *Hearth*, tho' they go upon it but five or six *Foundays*. The *Cynder*, like Scum, swims upon the melted Metal in the *Hearth*, and is let out once or twice before a *Sow* is cast.

*The Manner of Working Iron at the Forge or Hammer.*

In every Forge there are two Fires at least, which, as before is observed, are called, one the *Finery*, and the other the *Chafery*.

At the *Finery*, by the Working of the Hammer, they bring it into *Blooms* and *Anconies*, thus: They roll the *Sow* at first into the Fire, and then melt off a Piece of about  $\frac{3}{4}$  of a hundred Pound Weight; which, as soon as 'tis broken off, they call a *Loop*. This *Loop* they take out with their *Shingling-Tongs*, and beat it with *Iron Sledges* on an *Iron Plate* near the Fire, that so it may not fall in Pieces, but be in a Capacity to be carried under the Hammer, where it is beat very gently at first, only to draw *Cynders* and *Dross* out of the Matter: But afterwards they let out or draw more Water, and so by degrees beat it thicker and stronger, till they bring it to a *Bloom*; which is a four-square Mass, about two Foot long. This Operation they call *Shingling the Loop*. This done, they immediately return it to the *Finery* again; and after two or three Heats and Working, they bring it to an *Ancony*, whose Figure is in the middle a Bar of about three Foot long, and of the Shape they intend the whole Bar shall be made of; but at both Ends is a square Piece left rough, to be wrought at the *Chafery*.

*Note*, At the *Finery* three Load of the biggest Coals go to the making of one Tun of *Iron*.

At the *Chafery* they only draw out the two Ends suitable to what was drawn out at the *Finery* in the middle, and so finish the Bar.

*Note*, One Load of smaller Coals draws out a Tun of *Iron* at the *Chafery*.

At the *Finery*, they expect that one Man and a Boy should make two Tun of *Iron* in a Week; and at the *Chafery*, that two Men should *take up*, that is, make or work five or six Tun in a Week.

One thing is remarkable here: They say, That if into the *Hearth* where they work the *Iron Sows* (whether the *Finery* or the *Chafery*) you cast on the *Iron* a piece of Brass, it will hinder the Metal from working, causing it to spatter about so, that it cannot be wrought into a solid Piece. *Ray's Collect. of English Words*, at the End:

**IRON-SICK**, a Ship or Boat is said to be *Iron-sick*, when her Spikes are so eaten with Rust or Nails, and so worn away, that they make Hollows in the Planks, whereby the Ship leaks.

**IRONY**, is a Trope in Rhetorick, by which we speak contrary to our Thoughts; as to say, *Such a one is a very honest Man*, when we know he is notoriously corrupt.

**IRRADIATION**, is a Word used by *Van Helmont*, and some other Chymists, to express the Operation of some mineral Medicines, which they will have to impart their Virtue without emitting any thing material or substantial out of them, or without the Emanation of any corporeal Effluvia.

Thus, for instance, they tell you, that some Antimonial Preparations, as is *Glass* and *Crocus Metallorum*, will give an Emetick Quality to Wine, &c. without any manner of Diminution of its Weight: But it doth not appear that they were well enough exercised in statical Experiments, either to have nice Scales, or to know how to use them; and therefore, doubtless, do too boldly call that Diminution, which was only not so sensibly so to them: But how a Body should communicate its vomitive Quality to a Liquor, without impregnating it with some of its fine and subtil emetick Particles, is hardly possible to conceive.

**IRRATIONAL Numbers**: see *Surd Numbers*.

**IRRATIONAL Quantities**: see *Rational Quantities*.

**IRREGULAR Bodies**, are Solids which are not terminated by equal and like Surfaces.

**IRREGULAR**



**IRREGULAR Column**, [in *Architecture*] a Column that does not only deviate from the Proportions of any of the five Orders, but the Ornaments of which are ill chosen, either in the Shaft or Capital.

**IRREGULAR Fortification**: see *Fortification*.

**IRREGULAR Lines or Curves**: see *Regular*.

**IRREGULARITY**, in the Canon-Law, signifies an Impediment, which will hinder a Person's going into Holy Orders, as being a *Bastard*, *maimed*, *consenting to a Murder*, &c.

**IRREPLEVIABLE**, in the Common-Law, signifies what may not be *Replevied*, or set at large, upon *Sureties*.

**ISAGON** [ἰσωνόμος, of ἴσος *equal*, and γωνία, Gr. *a Corner*] in Geometry, is sometimes used for a Figure consisting of equal Angles.

**ISCHÆMA** [ἰσχίμων, Gr.] are Medicines that stop the Blood, which, with a binding, cooling, or drying Virtue, close up the Openings of the Vessels, or diminish and stop the Fluidity or violent Motion of the Blood. *Blanchard*.

**ISCHIADICK** [ἰσχιαδικός, of ἰσχίος or ἰσχίον, Gr. *the Hip*] an Epithet which Anatomists give to the Veins of the Foot, which terminate in the crural.

The *great ISCHIADICK* [in *Anatomy*] is formed by ten little Branches proceeding from the Toes, which uniting together pass by the Muscles of the Calf of the Leg.

The *lesser ISCHIADICK* [in *Anatomy*] is formed from the several Ramifications proceeding from the Skin and Muscles which encompass the Articulation of the Thigh.

**ISCHIAS** [ἰσχίος, Gr.] the Gout in the Hip.

**ISCHIUM** [ἰσχίον, Gr.] is the Hip or Huckle-Bone.

**ISCHURETICA**, are Medicines which force Urine, in the case of a Suppression of it.

**ISCHURIA** [ἰσχουρία, of ἰσχίον *to suppress*, and ὕδωρ, Gr. *the Urine*] is such a Suppression of Urine in the Bladder, that little or nothing of it can be discharged.

**ISLAND**, a Tract of Ground encompassed round with the Sea, or with Rivers. This Term is opposed to the Continent or *Terra firma*. Some conclude from *Gen. x. 5.* and from *Eccl. xliii. 25.* that Islands are as antient as the World, and that there were some at the Beginning. Whatever become of this Proof, 'tis by no means probable that the large Islands, far remote from the Continent, are new; or that they either arose out of the Sea, or were torn from the main Land. Nor is it less true, that there have been new Islands formed by the casting up of vast Heaps of Clay, Mud, Sand, &c. as that, for instance, of *Tsongming*, in the Province of *Tonquin* in *China*: or by the Violence of the Sea, which has torn off large Promontories from the Continent; as the Antients imagined *Sicily*, and even *Great Britain* were formed. It is also certain, that some have emerged above the Waves, as *Santorini* formerly, and three other Isles near it lately; the last in 1707, which rose from the Bottom of the Sea after an Earthquake, that was suppos'd to have loosen'd it from its Hold.

Several Naturalists are of Opinion, that the Islands were formed at the Deluge; others think they have been separated from the Continent by violent Storms, Inundations, and Earthquakes. These last have observed, that the *East-Indies*, which abound in Islands more than any other Part of the World, are likewise more annoy'd with Earthquakes, Tempests, Lightning, Vulcano's, &c. than any other Part. *Varenius* thinks most of these Opinions true

in some Instances, and believes that there have been Islands produced each of these Ways. *St. Helena*, *Ascension*, and other steep rocky Islands, he supposes to have become so, by the Sea's overflowing their neighbouring Chainpains. By the heaping up huge Quantities of Sand, and other terrestrial Matters, he thinks the Islands of *Zealand*, *Japan*, &c. were form'd. *Sumatra* and *Ceylon*, and most of the *East-Indian* Islands, he thinks were rent off from the main Land; and concludes that the Islands of the *Archipelago* were formed in the same way; imagining it probable, that *Deucalion's* Flood might contribute towards it. The Antients had a Notion, that *Delos*, and some few other Islands, rose from the Bottom of the Sea; which, how fabulous soever it may appear, agrees with later Observations. *Seneca* takes notice that the Island *Therassia* rose thus out of the *Ægean* Sea in his Time; of which the Mariners were Eye-witnesses. They had also an Opinion, that there are some Islands which swim in the Sea. *Thales*, indeed, thought that the whole Earth which we inhabit, floated thus in the Sea; but his Opinion is easily refuted, the Channel of the Sea being found continuous to the Shore: But floating Islands are no ways improbable, especially if the Earth whereof they consist be light and sulphureous. *Seneca* says, that near the *Cutylæ* he saw such an Island, and mentions several others of the same kind; and it was even a common Opinion among the Antients, that all the *Cyclades* had done the same.

**ISLES**, in *Architecture*, are Sides or Wings of a Building.

**ISOCHRONAL-LINE**, is that in which a heavy Body is supposed to descend without any Acceleration. And the excellent *G. G. Leibnitz*, in the *Act. Erud. Lips.* for *Febr. 1689.* hath a Discourse on this Subject; in which he shews, that an heavy Body, with a Degree of Velocity acquired by the Descent from any Height, may descend from the same Point, by an infinite Number of *Isochronal Curves*, and which are all of the same Species, differing from one another only in the Magnitude of their *Parameters* (such as are all the *Quadrato-Cubical Paraboloïds*) and consequently similar to one another.

He shews also there how to find a Line, in which a heavy Body descending shall recede uniformly from a given Point, or approach uniformly to it.

**ISOCHRONE** [ἰσόχρονον, Gr.] Vibrations of a Pendulum, are such as are made in the same Space of Time, as all the Vibrations or Springs of the same Pendulum are, whether the Arcs it describes be longer or shorter; for when it describes a shorter Arc, it moves so much the slower; and when a long one, proportionably faster.

**ISOMERIA**, [ἰσομερία, Gr.] in Algebra, is the same with *Conversion of Equations*, (see *Equations*, N. 1.) or of clearing any Equation from Fractions.

**ISOPERIMETRICAL Figures**, in Geometry, are such as have equal *Perimeters* or *Circumferences*.

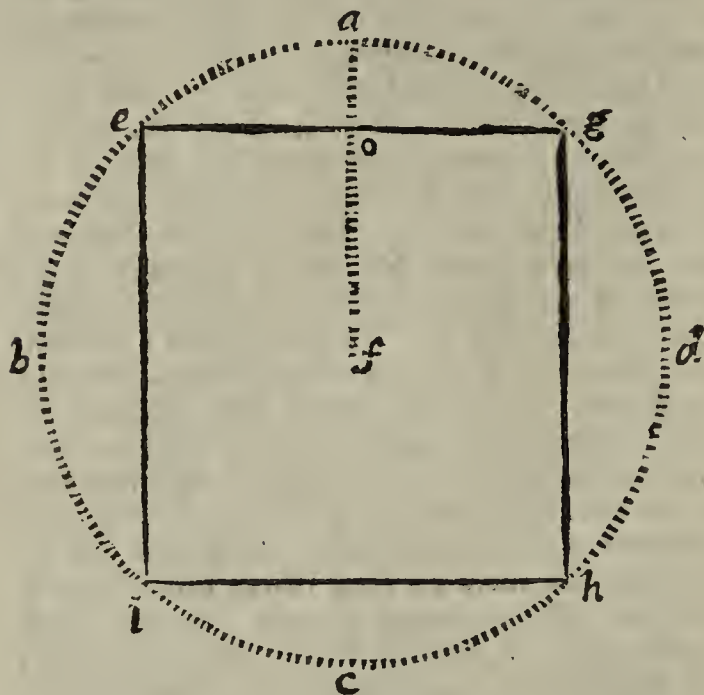
Of all *Iso-perimetrical Figures*, the *Circle* is the greatest.

For if a Right Line could be disposed into the Form of the Circumference of a *Circle*, it would contain more Space than any other Figure or *Regular Polygon* whatsoever.

As suppose the Circumference of the Circle *a b c d*, to be disposed into the Form of a Square, or any other *Regular Polygon*: so that all the Sides *e g*, *g h*, *h i*, and *i e* together, may be equal to the Cir-



cumference of the Circle  $abcd$ ; I say, the Circle is greater than that Square.

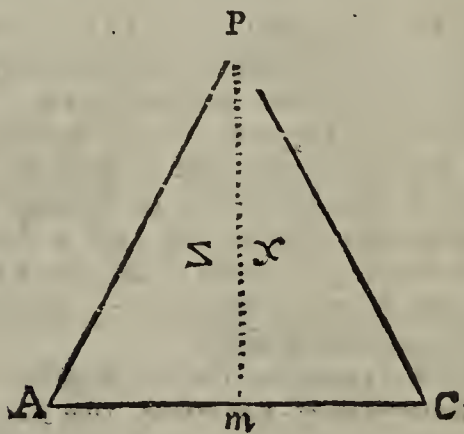


For the Circle is equal to a Rectangle-Triangle, one of whose Legs is the Radius  $fa$ , and the other the Circumference. And the Polygon is equal also to such a Triangle, one of whose Legs is the same Circumference  $abcd$ , or the Sum of the Sides  $geih$ : And the other Leg is the Line  $fo$ ; but as  $fo$  is less than the Radius  $fa$ , so the Triangle, which is equal to the Polygon, must be less than that which is equal to the Circle: Therefore the Square or Polygon must be less than the Circle. W. W. D.

ISOSCELES-TRIANGLE: see Triangle.

#### PROP. I.

The Angles opposite to the equal Sides of an *Iso-sceles-Triangle* are equal; and a Line drawn from the Top (or Vertex) cutting the Base into two equal Parts, is perpendicular to the Base.



Let the *Iso-sceles-Triangle* be  $APC$ , and let its Base  $AC$  be supposed to be divided into two equal Parts in  $m$ .

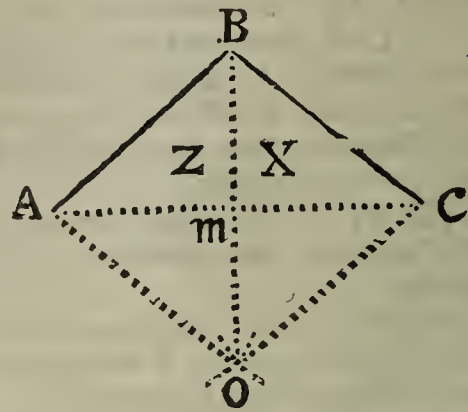
I say  $Pm$  is perpendicular to  $AC$ ; and the Angle  $PCA$ , is equal to the Angle  $PAC$ .

#### Demonstration.

For the Triangle  $Z$  hath all its Sides equal to those of  $X$ , and therefore must have all its Angles also respectively equal to those in  $X$ : And then the Angle  $PmA = PmC$ , because they are both right; therefore  $Pm$  is perpendicular to  $AC$ , and the Angle  $PAm = PCm$ . Q. E. D.

#### PROBLEM I.

To Divide a Right Line into Two equal Parts.



Let the Line given be  $AC$ , opening the Compasses to any Distance more than half the Line  $AC$ , and setting one Foot in  $C$ , strike an Ark both above and below the middle of the Line; then keeping them at the same Distance, set one Foot in  $A$ , and cross the former Arks in  $O$  and  $B$ ; a Ruler laid from  $O$  to  $B$ , shall cut the Middle of the  $AC$ , or divide it into two equal Parts.

#### Demonstration.

Draw the Lines  $AB$ ,  $BC$ ,  $BO$ ,  $AO$ , and  $CO$ .

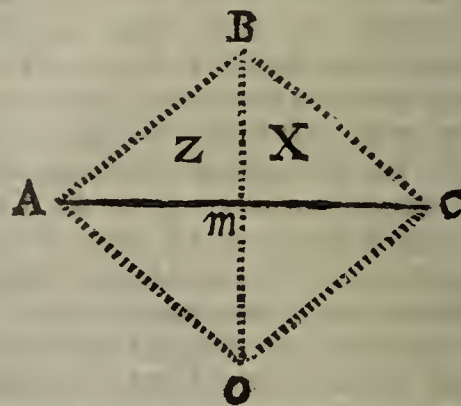
1. Then will the Triangles  $BAO$ , and  $BCO$ , have all their three Sides respectively equal, and consequently be equal to one another; and therefore the Angle  $CBO = \text{Angle } ABO$ .

2. The Triangles  $Z$  and  $X$ , have the same two Angles  $ABm$ , and  $CPm$  equal, and the Side  $AB$  equal to the Side  $BC$ , and  $Bm$  common to both: Therefore all are equal, and consequently  $Am = Cm$ . Q. E. D.

N. B. By this Problem also, a Perpendicular may be let fall to the middle of any given Line; for here 'tis plain  $Bm$  is perpendicular.

#### PROBLEM II.

To Divide an Angle given into Two equal Parts:  
Let the given Angle be  $ABC$ .



Open your Compasses to any convenient Distance, and setting one Foot in  $B$ , cross the Legs of the Angle in  $AO$ , strike an Ark below as at  $O$ , and removing the Compasses to  $A$ , cross the former Ark in the Point  $O$ , so a Line drawn from  $B$  to  $O$  shall bisect the Angle.

The Demonstration is the same with that of the last Problem.



**ISSUANT**, a Term in Heraldry, when a Lion, or other Beast, is drawn in a Coat of Arms just issuing out of the Bottom Line of any *Chief*, *Fesse*, &c. but if it come out of the Middle of any Ordinary, they call it *Naissant*; that is, *Nascent*, just coming out as it were from the Womb.

**ISSUE**, a Term in Common Law, having divers Applications; sometimes 'tis taken for the Children begotten between a Man and his Wife; sometimes for Profits growing from Amerciaments or Fines; and sometimes from Profits of Lands or Tenements; sometimes for that Point or Matter depending in Suit, whereupon the Parties join, and put their Cause to the Trial of the Jury: And yet in all these it hath but one Signification, which is an Effect of a Cause preceeding, as the Children be the Effect of the Marriage between the Parents: The Profits growing to the King or Lord, from the Punishment of any Man's Offence, is the Effect of his Transgression: The Point referred to the Trial of Twelve Men, is the Effect of Pleading or Process.

*Issue* in this last Signification, is either *General* or *Special*.

*General Issue*, seemeth to be that whereby it is referred to the *Jury* to bring in their Verdict, whether the Defendant hath done any such thing as the Plaintiff layeth to his Charge.

For Example:

If it be an Offence against any Statute, and the Defendant plead, *Not Guilty*; this being put to the Jury, is called, *The General Issue*.

And if a Man complain of a private Wrong, which the Defendant denieth, and pleads no Wrong nor Disseisin; and if this be referred to the Jury, it is likewise the *General Issue*.

The *Special Issue* then must be that, when Special Matters being alledged by the Defendant in his Defence, both Parties join thereupon, and so grow rather to a Demurrer, if it be *Quæstio Juris*, or to Trial by the Jury, if it be *Quæstio Facti*.

**ISSUES** [in *Surgery*] are small artificial Apertures made in a fleshy Part of the Body, to drain off superfluous Moisture, or give Vent to any noxious Humour.

**ISTHMUS**, a narrow Neck or Slip of Ground that joins two Continents, or joins a *Chersonesus* or *Peninsula* to the *Terra firma*, and separates two Seas. The most celebrated *Isthmus's* are those of *Panama* or *Darien*, which joins *North* and *South America*; that of *Suez*, which connects *Asia* and *Africa*; that of *Corinth*, or *Peloponnesus*, in the *Morea*; that of *Crim-Tartary*, otherwise called the *Taurica Chersonesus*; that near the Island of *Romania* and *Erisso*, or the *Isthmus* of the *Thracian Chersonesus*, twelve Furlongs broad; being that which *Xerxes* undertook to cut through. The Ancients had several Designs of cutting the *Isthmus* of *Corinth*, which is a rocky Hillock, about ten Miles over; but they were all vain, the Invention of Sluices being not then known. There have been Attempts too, for cutting the *Isthmus* of *Suez*, to make a Communication between the *Red-Sea* and the *Mediterranean*. The Word comes from the Greek *ἰσθμός*, a Neck. Hence Anatomists use the Term for several Parts of the human Body, particularly that narrow Part of the Throat situate betwixt the two Tonils; and the Ridge that separates the two Nostrils.

**ISTHMUS**, in Anatomy, is a Passage in that Part of the *Medulla Oblongata* of the Brain, which lies between the *Cerebrum* and *Cerebellum*; and which reaches from the Place called the *Anus* to the fourth

Ventricle. The upper Part or Cover of this Conduit or Passage, which is betwixt the *Testes* and the foremost vermicular Process of the *Cerebellum*, and to which two it is tied at its two Ends, and to the Processes that come from the *Cerebellum* to the *Testes*, at its Sides, is called *Valenta major*: It is of a medullary Substance; and its Use is to keep the *Lympha* from falling out above the Nerves in the *Basis* of the Skull.

**ISTHMUS**, in Anatomy, according to some, is that Part which lies betwixt the Mouth and the Gullet, like a Neck of Land; also the Ridge that separates the Nostrils.

**ITALIAN Hours**, are the 24 Hours of the natural Day, accounted on from the Sun-setting of one Day, to the same time again the next Day, as 'tis the Custom in *Italy* to do at this Day, and as the *Jews* did of old.

**ITHMOIDEA** *Offa*: see *Ethmoides*.

**ITINERANT Judges** or *Justices*, are such as were formerly sent with Commission into divers Countries, to hear chiefly such Causes as were called *Pleas of the Crown*, the same with *Justices in Eyre*; which see.

**ITINERARIUM**, is a Chyrurgeon's Instrument, which being fixed in the Urinary Passage, shews the Neck or Sphincter of the Bladder, that an Incision may be more surely made to find out the Stone: 'Tis usually thrust up thro' the Cavity of a Fistulous Catheter, which saves it from wounding the *Urethra* as it goes.

**JUBA**, a Botanick Work, signifying a soft loose Beard, which hangs at the Ends of the Husks of some Plants of the *Frumentaceous Kind*; as particularly in *Millet*.

**JUBILEE**, is a solemn Time of Festivity at *Rome*, in which the Pope pretends to give Pardons, Indulgences, and Blessings, to such rich credulous Persons as have as much *Money* as *Faith*, and who have leisure enough to go thither to fetch them. The first Jubilee is said to have been instituted by Pope *Boniface VIII.* A. D. 1300. to return every Hundred Years. But Pope *Clement VI.* thought such a Fair of Indulgences should be kept oftner; and so he order'd that the *Jubilee* should return again every Fifty Years; which was decreed A. D. 1350.

In Imitation of this profitable Pardon-Market at *Rome*, the Monks of *Christ's-Church* in *Canterbury* set up a *Jubilee* of their own every Fiftieth Year also, to get a Concourse of Fools to the Shrine of that insolent Prelate *Thomas Becket*.

Our King *Edward II.* kept a kind of *Civil Jubilee* at his Court in the Fiftieth Year of his own Age, which was in 1362, granting Pardons, Privileges, and other Civil Indulgences.

**JUDGE** and *Judges*, have all their Commissions bounded with this Limitation, *Facturi quod ad justitiam pertinet secundum legem & consuetudinem Angliæ*.

The *Judge* at his Creation takes this Oath, "That he shall indifferently minister Justice to all  
"them that shall have any Suit or Plea before him;  
"and this he shall not forbear to do, though the  
"King by his Letters, or by express Word of Mouth,  
"should command the contrary, &c.

**JUDGMENT**, in Law, is the Censure of the Judges so called, and is the very Voice and Final Doom of the Law, and therefore is always taken for unquestionable Truth.

Of *Judgments*, some are *Final*, and some *not Final*. See *Coke* and *Littleton*, Fol. 39.

JUDGMENT.



**JUDGMENT**, Mr. *Locke* defines to be a Faculty of separating carefully one from another, those Idea's wherein any, even the least Difference can be found, thereby to avoid being misled by Similitude and by Affinity, to take one thing for another.

Others define it to be that Action of the Mind, by which assembling together several Idea's, we either deny or affirm *This* to be *That*.

Thus, considering the Idea of the Earth, and the Idea of Roundness, we affirm or deny the *Earth* to be round.

**JUDICIUM Dei**. Our Ancestors used to call those now prohibited Trials of guilty Persons by *Ordeal*, *Judicium Dei*, the Judgment of God. See *Ordeal*.

**JUGALE Os**, the same that *Zygoma*.

**JUGULAR-VEINS**, are those Veins which go towards the Skull by the Neck; and are of two sorts, *viz.* External and Internal.

The *External Jugulars* ascend on the Outside of the Neck, and are usually open'd where one is let Blood in that Part for any Distemper in the Head, *Quincey*, &c.

The *Internal Jugulars* arise from the *Subclavian*, by the sides of the Wind-pipe, and passing along the Skull in two Branches, are dispersed thro' the *Dura Mater*, &c.

**JUGULUM**, the same that *Furcula*.

**JUGUM Terræ**, is half an Arpent, or fifty Perches, mention'd in *Domesday-Book*, and interpreted there to contain half a Plough-land.

**JULAP**, from the Greek *ζυλάμα*, or, as some say, from the Persick Word *Juleb*, which signifies a *sweet Potion*; is a grateful Medicine composed of Distilled Waters, Spirits, &c. and sweetened to the Patient's Palate with Sugar, or some agreeable Syrup.

**JULIAN-YEAR**, is the *Old Account* of the Year, instituted by *Julius Cæsar*, which to this Day we use in *England*, and call it the *Old Style*, in Contradistinction to the *New Account*, framed by Pope *Gregory*, which is Eleven Days before ours, and is called the *New Style*.

**JULIAN-PERIOD**, is a Cycle of 7980 Consecutive Years, produced by the continual Multiplication of the three Cycles, *viz.* That of the *Sun* of 28 Years, that of the *Moon* of 19 Years, and that of the *Indiction* of 15 Years; so that this *Epocha*, although but artificial or feign'd, (and which was the Invention of the famous *Julius Scaliger*) is yet of very good Use; in that every Year within the Period, is distinguishable by a certain peculiar Character; for the Year of the *Sun*, *Moon*, and *Indiction* will not be the same again, till the whole 7980 Years be revolved; *Scaliger* fix'd the Beginning of this Period 764 Years before the Creation.

*For the finding the Year of the Julian Period,  
you have this Rule,*

Multiply the *Solar Cycle* by 4845, the *Lunar* by 4200, and the *Indiction* by 6916;

Then divide the Sum of those Products by 7980, and the Remainder of the Division (without having Regard to the Quotient) will be the Year enquired after.

*Example.*

Let the Cycle of the *Sun* be 3, of the *Moon* 4, and of the *Indiction* 5.

Multiply 8485 by 3, 'twill be 14535; and 4200 by 4 = 16800; and 6916 by 5, gives 35580.

The Sum of the Products is 65915, which divided by 7890, gives 8 in the Quote, and leaves 2075 for a Remainder, which is the Year of the *Julian Period*.

**JULUS**, is a Botanick Word for those *Catalins*, as some call them, or long Worm-like Tufts or *Palms*, as they are called in Willows, which at the Beginning of the Year grow out of, and hang pendulous down from Hazels, Walnut-trees, &c.

The accurate Mr. *Ray* thinks them to be a kind of Collection of the *Stamina* of the Flowers of the Tree; because in fertile Trees and Plants they have abundance of seminal Vessels or Seed-Pods.

**JUPITER**, one of the seven Planets; its Character is ♃. Its Orbit is situate between *Saturn* and *Mars*. It has a Rotation round its own Axis in 9 Hours, 56 Minutes; and a periodical Revolution round the Sun in 4332 Days, 12 Hours. It is the biggest of all the Planets; its Diameter to that of the Sun appears, by astronomical Observations, to be as 1077 is to 10000; to that of *Saturn* as 1077 to 889; to that of the Earth as 1077 to 104. The Force of Gravity on its Surface is to that on the Surface of the Sun as 797.15 is to 10000; to that of *Saturn* as 797.15 to 534.337; to that of the Earth as 797.15 to 407.832. The Density of its Matter is to that of the Sun as 7404 to 10000; to that of *Saturn* as 7404 to 6011; to that of the Earth as 7404 to 3921. The Quantity of Matter contained in its Body is to that of the Sun as 9,248 to 10000; to that of *Saturn* as 9,248 to 4.223; to that of the Earth as 9,248 to 0.0044. The mean Distance of *Jupiter* from the Sun is 5201 of those Parts, whereof the mean Distance of the Earth from the Sun is 1000, though *Kepler* makes it 5196 of those Parts. M. *Cassini* calculates *Jupiter's* mean Distance from the Earth to be 115,000 Semi-Diameters of the Earth. *Gregory* computes the Distance of *Jupiter* from the Sun to be above five times as great as that of the Earth from the Sun; whence he gathers, that the Diameter of the Sun, to an Eye placed in *Jupiter*, would not be a fifth Part of what it appears to us; and therefore his Disk would be twenty-five times less, and his Light and Heat in the same Proportion. The Inclination of *Jupiter's* Orbit, that is, the Angle formed by the Plane of its Orbit, with the Plane of the *Ecliptic*, is 1 Deg. 20 Min.; his Excentricity is 250; and *Huygens* computes his Surface to be four hundred times as large as that of our Earth.

*Jupiter* is one of the Superior Planets, that is, one of the three above the Sun; hence it has no Parallax, its Distance from the Earth being too great to have any sensible Proportion to the Diameter of the Earth. Though it be the greatest of the Planets, yet its Revolution about its Axis is the swiftest. Its Polar Axis is observed to be shorter than its Equatorial Diameter; and Sir *Isaac Newton* determines the Difference to be as 8 to 9: So that its Figure is a Spheroid, and the Swiftness of its Rotation occasions this Spheroidism to be more sensible than that of any other of the Planets. *Jupiter* appears almost as large as *Venus*, but is not altogether so bright. He is eclipsed by the Moon, by the Sun, and even by *Mars*. *Hevelius* observed *Jupiter's* Diameter 7 Inches, having Inequalities like the Moon. He has three Appendages, call'd Zones, or Belts, which Sir *Isaac Newton* thinks are form'd in his Atmosphere. In these are several *Macule*, or Spots; from whose Motion the Motion of *Jupiter* round its Axis is said to have been first determined. The Discovery of this is controverted between *Eustachio*, P. *Gotignies*, *Cassini*, and



and *Campani*. The four little Stars or Moons, which move round *Jupiter*, were first discover'd by *Galileo*, who called them the *Astra de Medicis*, but we the *Satellites* of *Jupiter*. *Cassini* observed, that the first or innermost of these *Satellites* was five Semi-diameters of *Jupiter* distant from *Jupiter* itself, and made its Revolution in 1 Day, 18 Hours, and 32 Minutes. The second, which is somewhat greater, he found 8 Diameters distant from *Jupiter*, and its Revolution 3 Days, 13 Hours, and 12 Minutes. The third, which is the greatest of all, is distant from *Jupiter* 13 Semi-diameters, and finishes its Course in 7 Days, 3 Hours, and 50 Minutes. The last, which is the least of all, is distant from *Jupiter* 23 Semi-diameters; its Period is 16 Days, 18 Hours, and 9 Minutes. These four Moons must make a very pleasing Spectacle to the Inhabitants of *Jupiter*, if it be true there are any; for sometimes they rise all together; sometimes they are all together in the Meridian, ranged one under another; and sometimes all appear in the Horizon, and frequently undergo Eclipses; the Observations whereof are found of especial Use in determining the Longitude. *Cassini* has made Tables for calculating the Immersions and Emergences of *Jupiter's* first *Satellite*.

**JURATS**, are in the Nature of Aldermen, for Government of their several Corporations: As the *Mayor* and *Jurats* of *Maidstone*, *Rye*, *Winchelsea*, &c. So *Fersey* hath a Bayliff and twelve *Jurats*, or sworn Assistants, to govern the Island.

**JURIDICAL Days**, the same with *Court-Days*.

**JURISDICTION**, is a Dignity which a Man has conferr'd on him to do Justice in Cases of Complaint made before him. Of this there are two Kinds; one, which a Man hath by reason of his *Fee*, of doing Right in all Plaints relating to his *Fee*, by Vertue thereof. The other is collated by a Prince to a *Bailiff*; which in a large Sense may signify all such as have Commission from the Prince to give Judgment in any Case.

**JURIS-PRUDENCE** [*Juris prudentia*, L.] the Knowledge of what is just or unjust, or of the Laws, Rights, Customs, Statutes, &c. necessary for the doing of Justice; and is either *Civil*, *Canonical*, and *Fædal*. The *Civil Juris-prudence* is that of the *Roman Law*, the *Canonical Juris-prudence* is that of the *Canon Law*.

**JURIS Utrum**, is a Writ that lieth for the Incumbent, whose Predecessor hath alienated his Lands or Tenements.

**JUROR**, is one of those twenty-four or twelve Men, which are sworn to deliver the Truth upon such Evidence as shall be given them touching the Matter in question.

**JURY**, in Common Law, signifies either twenty-four or twelve Men sworn to enquire of the Matter of Fact, and declare the Truth upon such Evidence as shall be deliver'd them touching the Matter in Question: Of which *Jury* some may, and some may not be impannell'd. See *F. N. B. Fol. 165*.

In *England* there are three Sorts of Trials, viz. one by Parliament, another by Battle, and the third by Assize or Jury.

The Trial by *Assize* (be the Action Civil or Criminal, Publick or Private, Personal or Real) is referred for the Fact to a *Jury*; and as they find it, so passeth the Judgment.

This *Jury* is not only used in Circuits of Justices Errant, but also in other Courts and Matters of Office: And though it appertains to most Courts of the Common Law, yet it is most notoriously in

the Half-year Courts of the Justices Errants, commonly called the *Great Assizes*, and in the Quarter-Sessions; and in them it is most ordinarily called a *Jury*, and that in a Civil Cause; whereas in other Courts 'tis usually called an *Inquest*, and in the Court-Baron a *Jury of the Homage*.

In the *General Assize* there are usually many *Juries*, because there be store of Causes both Civil and Criminal commonly to be tried; whereof one is called the *Grand Jury*, and the rest *Petit Juries*; whereof it seemeth there should be one in every Hundred.

The *Grand Jury* consists of twenty-four grave and substantial Gentlemen, or some of the better sort of Yeomen, chosen indifferently by the Sheriff out of the whole Shire, to consider of all Bills of Indictment preferred to the Court; which they do either approve, by writing upon them, *Billa vera*; or disallow, by endorsing *Ignoramus*. Such as they do approve, if they touch Life and Death, are further referred to another *Jury* to be consider'd of, because the Case is of such Importance; but others of lighter Moment are, upon their Allowance, without more Work, fined by the Bench; except the Party traverse the Indictment, or challenge it for Insufficiency, or remove the Cause to a higher Court by *Certiorari*; in which two former Cases it is referred to another *Jury*; and in the latter, transmitted to a higher: And presently upon the Allowance of this Bill by the *Grand Inquest*, a Man is said to be *Indicted*: Such as they disallow are delivered to the Bench, by whom they are forthwith cancelled or torn.

The *Petit Jury* consists of twelve Men at the least, and are empannell'd as well upon Criminal as upon Civil Causes. Those that pass upon Offences of Life and Death, do bring in their Verdict either Guilty, or not Guilty; whereupon the Prisoner, if he be found guilty, is said to be Convicted; and so afterwards receiveth Judgment and Condemnation; or otherwise is acquitted and set free. Those that pass upon Civil Causes Real, are all, or so many as can conveniently be had, of the same Hundred where the Land or Tenement in question doth lie; being four at least; and they, upon due Examination, bring in their Verdict either for the Demandant or Tenant.

**JURY-MAST**; so the Seamen call whatever they set up in the room of a Mast lost in a Fight; or by a Storm; which, if they can save it, some great Yard, which they put down into the Step of that lost Mast, fastening it into the Partners, and fitting to it the Miffen, or some lesser Yard, with Sails and Ropes, as they can, they make a hard shift to sail with it instead of the Mast which they have lost.

**JUS Honorarium**, or the *Edicts of the Prætors*, was a Part of the written *Roman Laws*, and was what the *Prætors*, and such kind of Magistrates, did propose by the Consent of the People.

**JUS Retractus sive Retrovendendi**, in the Civil Law, is an Agreement between Buyer and Seller, that the latter and his Heirs may buy back the Goods or Wares again before any other.

**JUSTICE**. The Virtue of *Justice* is either *Universal* or *Particular*. *General* or *Universal Justice* is a constant giving to every one his Due; and this hath for its Object all Laws both Divine and Human. *Particular Justice*, is a constant Will and Desire of giving every one his Due, according to particular Agreement, or the Laws of Civil Society. *Particular Justice*, as 'tis exercised in Commerce, is usually called *Commutative*, and sometimes *Ex-*



*pletory Justice*, being directed without any Regard to the different Conditions of Men, but observes the simple Proportion, and is wholly bent on the Value or Price of Things, or what is really and justly due. But if you consider *Particular Justice*, as it is exercised in *Governing*, or in *Beneficence*, it is called *Distributive* or *Attributive Justice*; and is concern'd in the appointing of Rewards and Punishments, according to the several Conditions, Stations and Qualities of Men, according as they are more or less good or bad, useful or prejudicial, worthy or unworthy. And when there are many Claimers for Rewards, it observes a *Comparative Proportion*.

JUSTICE, signifies him that is deputed by the King to do Right by way of Judgment. Of these *Justices* there are divers Sorts in *England*; of the manner of whose Creation, with other Appurtenances, read *Fortescue*, cap. 51.

JUSTICE of the *Hundred*, was formerly the same with the *Dominus Hundredi*; called also *Centurio*, *Centenarius*, and *Aldermannus*.

JUSTICE of the *Common-Pleas*, is a Lord by his Office, and with his Assistants originally did hear and determine all Causes at the Common Law; that is, all Civil Causes between Common Persons, as well Personal as Real; for which Cause it is call'd the *Court of Common-Pleas*, as distinguishing it from the *Pleas of the Crown*, or the *King's Pleas*, which are Special, and appertaining to him only.

JUSTICE of the *Forest*, or *Justice in Eyre of the Forest*, is a Lord by his Office, and hears and determines all Offences within the Forest, committed against Venison or Vert. Of these there be two, whereof one hath Jurisdiction, over all Forests on this side *Trent*, the other of all beyond.

JUSTICE of the *King's-Bench*, is a Lord by his Office while he enjoys it, and the chief of the rest. His Office (especially) is to hear and determine all Pleas of the Crown, viz. such as concern Offences committed against the Crown, Dignity, and Peace of the King; as Treasons, Felonies, Mayhems, and such-like: He also, with his Assistants, heareth all Personal Actions, and Real also, if they be incident to his Jurisdiction.

JUSTICE Seat, is the highest Court that is held in a Forest, and before the Lord Chief Justice in Eyre of the Forest, upon Warning given 40 Days before; and then the Judgments are always given, and the Fines set for Offences, that were presented at the Courts of *Attachments*, and the Offenders indicted at the *Swain-Motes*. See *Manwood's Forest Law*, c. 24.

JUSTICES of *Labourers*, were *Justices* heretofore appointed to redress the *Forwardness* of Labourers, that would either be *Idle*, or have *unreasonable Wages*.

JUSTICES of the *Pavillion*, are certain Judges of a *Pie-Poudre Court*, of a most transcendent Jurisdiction; anciently authorized by the Bishop of *Winchester*, at a Fair held on *St. Giles's-Hill*, near that City, by Virtue of Letters-Patents granted from King *Edward IV.* See the Patents at large in *Prynne's Animadu.* on 4 *Instit.* fol. 191.

JUSTICES of the *Peace*, are they that are appointed by the King's Commission to preserve the Peace of the Country where they dwell. Of these some are made of the *Quorum*, because some Business of Importance cannot be dispatched (see *Quorum*) without the Presence or Assent of them, or one of them.

The Office and Power of the Justices of the Peace is very large and various, being founded on

several Statutes; of which, see *Fitzherbert*, *Lambert*, *Crompton*; and in *Smith de Repub. Aulor.* lib. 2. cap. 9. They are called *Guardians of the Peace* till 36 *Edw. 3.* cap. 12. where they are stiled *Justices*. Those that live in, and are Members of Towns, Corporations, &c. are called *Justices within Liberties*.

JUSTICES of *Traile Baston*, were a kind of Justices appointed by *Edward the First*, on great Disorders arising in the Kingdom, while he was absent in the *Scotch* and *French Wars*. Their Office was to make Inquisition throughout the Realm, by the Verdict of substantial Juries, upon all Officers, as Mayors, Sheriffs, Bailiffs, &c. for their Breach or Neglect of Duty, in not punishing Bribery, Extortion, &c. 'Tis most likely they received their Name from a *Baston*, or Staff, that was the Badge of their Office, as it is of a *Mareschal of France*: And whoever was brought before them, was *Traile à Baston*, *traditus ad Baculum*, brought to the Staff of Justice.

JUSTICES of *Assize*, are such as were wont by Special Commission to be sent into this or that County, to take Assizes for the Ease of the Subjects; for whereas these Actions pass always by Jury, so many Men might not, without great Damage and Charge, be brought up to *London*; and therefore Justices for this Purpose, by Commission particularly authorized, were sent down to them: And twice every Year they go the Circuit, by two and two, through all *England*, dispatch their several Businesses by several Commissions; for they have one Commission to take *Assizes*, another to deliver Gaols, and another of *Oyer and Terminer*, &c.

JUSTICES in *Eyre*, are those who were sent with Commission into divers Counties to hear Causes, especially those that were termed *Pleas of the Crown*: And this was done for the Ease of the People, who would else have been hurried to the *King's-Bench*, if the Cause were too high for the County-Court.

JUSTICES of *Goal-Delivery*, are such as are sent with Commission to hear and determine all Causes appertaining to such as for any Offence are cast into the Gaol.

JUSTICES of *Nisi Prius*, are now all one with *Justices of Assize*; for it is a common Adjournment of a Cause in the *Common-Pleas*, to put it off to such a Day, *Nisi prius justiciarii venerint ad eas partes ad capiendas Assisas*: And upon this Clause of Adjournment they are called *Justices of Nisi Prius*, as well as *Justices of Assize*, by reason of the Writ or Action they have to deal in.

JUSTICES of *Oyer and Terminer*, were Justices deputed upon some special or extraordinary Occasion, to hear and determine some peculiar Causes.

JUSTICES, is a Writ directed to the Sheriff, for the Dispatch of Justice in some special Cause, of which he cannot by his ordinary Power hold Plea in his County-Court.

By this Writ *Justicies*, the Sheriff may hold Plea of a great Sum; whereas by his ordinary Authority he can hold no Pleas but of Sums under forty Shillings.

JUXTA-POSITION, is the ranging the Particles or Corpuscles of any mix'd Body into such an Order, Position, or Situation, that the Particles being contiguous to one another, shall determine or denominate a Body to be of such a Figure or Nature, or to be endued with such Properties as are the proper Result of such a Configuration and Disposition of Parts.



**K**ALENDÆ, were formerly Rural Chapters, or Conventions of the Rural Dean and Parochial Clergy; so called, because they were held on the Kalends, or first Days of every Month; as at first every three Weeks: At last these Conventions came to be held only once a Quarter; and by degrees have been wholly intermitted, to the great Decay of good Discipline. *Parochial Antiquities*, p. 640.

KALENDAR: See *Calendar*.

KALENDAR *Month*, is mentioned in 16 *Car.* 2. cap. 7. and consists of 30, or 31 Days (except *February*, which never hath more than 28 Days, excepting *Leap-Year*, and then has 29) twelve of which being those mentioned in the *Kalendar*, make a Year; which hence is vulgarly express'd in the Singular Number, and called a *Twelve Month*: But when in the Plural Number we say *Twelve Months*, then it shall be accounted a *Month of Weeks*, which is but 28 Days.

KALENDAR. There is in Use still in *Staffordshire*, among the common People, a very peculiar Kind of perpetual *Kalendar* or Almanack, which Dr. *Plott*, in his *Natural History* of that County, describes very accurately, and proves to be of *Danish* Invention, and no doubt brought in when the *Danes* had the Government of this Kingdom.

It is called there the *Clogg*, I suppose from its Form and Matter, being usually made of a Piece of Wood, squared into four plane Sides, and with a Ring on the upper End of it, to hang it on a Nail somewhere in the House.

There is some Diversity in the Form of them, some being more perfect than others. The following Figure, which I borrow from Dr. *Plott*, represents the Common or Family *Clogg*, where each Angle of the *Square Stick*, with one half of each of the flat Sides belonging to it, is express'd; and this is the most clear and intelligible Form it can well appear in upon a Flat.

On each of the four Sides are three Months, the Number of the Days being represented by the Notches; that which begins every Month having a patulous Stroke turn'd up from it: Every seventh Notch, being also of a larger Size, stands for *Sunday*, which seems to shew that the Cycle of the Sun or Dominical Letters, are here committed to Memory; the *Sundays* and other Days here being fix'd.

Over against many of the Notches, whether great or small, there are placed on the Left Hand several Marks or Symbols, denoting the *Golden Number*, or Cycle of the Moon; which Number, if under 5, is represented by so many Points; but if it be 5, then a Line is drawn from the Notch or Day to which it belongs, with a *Hook* returned back against the Course of the Line; which seems to be design'd to represent V the Roman Letter for 5.

If the *Golden Number* be above 5 and under 10, then 'tis mark'd out by the former hooked Line for 5; and with the Addition of as many Points as make up the Number design'd, As if it be 8, there are three Points added to the hooked Line, &c.

When the *Golden Number* is 10, there is a Cross on the Notch to represent X; and if it be above, and under 15, 'tis express'd by Points as before; and if above 15, by the cross Stroke, Points, and a hook Line for V. When 'tis 19, the Line issuing from the Notch for the Day, hath two patulous Crosses, or Strokes, as is plain from the following Figure.

And these Numbers are not set so wildly and confusedly against the Days of the Month, as at first Sight may appear, but in a Method and Order; whether you consider them as they immediately precede and follow one another, or the *Distance* interceding each Figure, or the *Value*, or Denomination; for every following Number is made by adding 8 to the preceding; and every preceding one, by adding 11 to the following one; still casting away 19, the whole Cycle, when the Addition shall exceed it. Thus to 3, which stands against *January* 1, add 8, it makes 11; which stands against the third Day of the Month; to which add 8 again, and it makes 19; whence 8 itself comes to be the following Figure, and 16 the next: On the contrary, if to 16 you add 11, it makes 27; whence deducting 19, there remains 8, the Number above it; and so on, &c.

And for the *Distances* of the Numbers of the same Denomination, 'tis to be noted that they stand asunder either 30 or 29 Days, interchangeably. Thus after 3, which stands over-against the 1st of *January*, at 30 Days Distance you will find 3 again at the 30th of the same Month; and from thence, at 29 Days Distance, you will have 3 again set to the 1st of *March*; and at the last of *March*, at 30 Days Distance, 3 again, &c.

Note, 3 stands against the 1st of *January*, because 3 was the *Golden Number*, when the Fathers of the *Nicene Council* settled the Time for the Observation of *Easter*. See *Plot*, in *Loc. cit.*

On the Right Hand, and issuing from the Notches, are several *Inscriptions* and Figures, Hieroglyphically representing the *Festival Days*, by some Actions, Offices, or Endowments of the Saints; or else the *Work* or *Sport* in fashion at the Time of the Year.

Thus from the Notch of *January* 13, being St. *Hillary's* Day, issues a Cross, the Badge of a Bishop. From the 1st of *March* an Harp for St. *David*. Against *June* 29, St. *Peter's* Day, you have his Keys: And against St. *Crispin's* Day a Pair of Shoes. Against *January* 25, St. *Paul's* Day, there is an Ax: And against *June* 24, a Sword for St. *John Baptist*. On *August* 10th, a Gridiron for St. *Lawrence*. So a Wheel for St. *Katherine*, a Star for *Epiphany*, a *True-Lover's-Knot* for Saint *Valentine's* Day, &c. And against *Christmas-Day*, is the old *Wasbailing*, or *Carousing-Horn*, that the *Danes* used to make merry withal at that Time.

The





The Use of this Clogg is chiefly to find by the Prime or Golden Number the Ecclesiastical New Moons, and the Moveable Feasts; and the Immoveable Feasts by the Symbols on the Right Hand.

**KALENDS:** See *Calends*.

**KANT-Rref,** was used anciently in *Wales* for the Government of an hundred Towns; under which were so many *Commons*, which the *Welch* call *Cwmwd*, and signifies *Provincia* or *Regio*, and consisted of twelve Manors or Circuits, and two Townships.

**KARITE,** or *Carite*, was the Word used formerly by the Religious for their best Conventual Drink, or Strong Beer; because in this they drank their *Poculum Caritatis*, or Grace-Cup: Which Grace-Cup itself was sometimes called by the Name of *Karite* or *Carite*.

**KECKLE;** when the Cables of a Ship gaul in the Hawse, or the Bolt-ropes do so against the Ship's Quarter, the Seamen wind some small Ropes about them; and this serving of these Ropes is called *Keckling*.

**KEDGING,**



**KEDGING**, at Sea, is when a Ship is brought up or down in a narrow River, the Wind being contrary to the Tide, and yet she is to go with the Tide; then they use to set their Fore-sail, or Fore-top-sail and the Miffen, and so let the Ship drive with the Tide, that so they may flat her about; and if she happen to come over too near the Shoar, they have a small Anchor in the Head of their Boat with a Hawser fasten'd to it from the Ship, which Anchor they then let fall in the Middle of the Stream, and so wind or turn her Head about, lifting the Anchor up again when she is come fully about: This Work is call'd *Kedging*, or to *kedg* up a River, and the Anchor made use of is called the

**KEDGER**, or *Kedge-Anchor*.

**KEEL**, is the lowest Piece of Timber in a Ship, in the Bottom of her Hull; one End whereof is at the *Stern*, the other at the *Stem*: Into this are all the Ground-Timbers and Hooks fasten'd, and bolted fore and aft. When a Ship hath a deep Keel, she is said to have a *Rank Keel*; and this serves well to keep her from rowling; but if she is over-floaty and rowls too much, a new Keel is sometimes put on, called a *False Keel*.

**KEEL-ROPE**, a Hair-Rope running between the *Keelson* and the *Keel* of a Ship, to clear the limber *Holes* when they are choaked up with Ballast, &c.

**KEELS** or *Keyles*, were a kind of Long-Boats of great Antiquity, and mentioned 23 H. 8. 18. *Spelman* saith they were those in which the *Saxons* invaded *England*.

**KEELSON**, the next Piece of Timber in a Ship to her Keel, lying right over it next above the Floor-Timber.

**KEEPER** of the *Great Seal*, is a Lord by his Office, and stiled *Lord-Keeper of the Great Seal of England*: He is one of the King's Privy-Council; through whose Hands pass all Charters, Commissions, and Grants of the King under the *Great Seal*; without which Seal all such Instruments by Law are of no Force: For the King is, in the Interpretation of Law, a Corporation, and passeth nothing firmly but under the said Seal, which is as the publick Faith of the Kingdom, in the high Esteem and Reputation justly attributed thereto.

This *Lord-Keeper* hath the same Place, Authority, Pre-eminence, Jurisdiction, Execution of Laws, and all other Customs, Commodities, and Advantages, as the *Lord Chancellor of England* hath for the Time being. He is constituted by the Delivery of the *Great Seal* to him, and taking his Oath.

**KEEPER** of the *Privy Seal*, is a Lord by his Office, through whose Hands pass all Charters sign'd by the King, before they come to the *Great Seal*, and some things which do not pass the *Great Seal* at all. He is of the King's Privy-Council, and one of the Great Officers of the Kingdom.

**KEEPER**, or *Chief Warden of the Forest*, is he who hath the principal Government of all things belonging to the same.

**KELP**, what it is, and how made, see under *Allum Works*.

**KENKS**, in the Sea-Phrase, are Doublings in a Cable or Rope, when 'tis handed in or out, so that it doth not run smooth; or when any Rope makes Turns, and doth not run smooth and cleaver in the Block, they say it makes *Kenks*.

**KENNETS**, in a Ship, are small Pieces of Timber nailed to the Inside of the Ship, unto which the *Tacks* and *Sheets* are belayed, (as they call it) i. e. fasten'd.

**KERF**, is the Notch or Slit that is made by the Saw between two Pieces of Wood, when they are sawing asunder.

**KERNELLATUS**, anciently signified *Embatel-elled* or *Crenelled*, i. e. *Fortified*: And

**KERNELLARE** *Domum*, was to build a House with such Walls and Towers; which to be allow'd to do, was a Favour commonly granted by our Kings after the Demolishments of the Castles.

**KETCH**, a smaller Vessel, but of the same Form with a *Hoy*.

**KEVELS**, or *Chevils*, are small Pieces of Timber nailed to the Inside of a Ship, unto which the *Tacks* and *Sheets* are belayed or fasten'd.

**KEY**, in Musick, is a certain Tone, whereto every Composition, whether it be long or short, ought to be fitted or design'd: And this Key is said to be either *Flat* or *Sharp*, not in respect of its own Nature, but with relation to the Flat or Sharp Third, which is joined with it. See *Musick*.

**KEystone** in an Arch, is placed at the Top or Vertex of Elliptical or such-like flat Arches, to bind the Sweeps of the Arch together.

**KIDNEYS**. The Kidneys in Man are always two in Number, one on each Side, being nearly of the Figure of the *French* or *Kidney-Beans*; which latter Name they take from being like the Kidneys.

The Length of the human Kidney is between four and five Fingers Breadth. They are about two Fingers Breadth in Thickness, and three over. The Right Kidney is situated under the Liver; the left under the Spleen.

In a Fœtus their external Substance is divided into several Lobes join'd together, which in adult Persons become more close; wherefore in such their Surface is equal and smooth. They have two Membranes; one *common* from the *Peritonæum*, the other *proper*. Usually they are cover'd with a good deal of Fat; their Colour is of a dark Red.

There are several *Lymphatic Vessels* observed in the Kidneys, which discharge themselves into *Pecquet's Repository*: The *Veins* go into the *Vena Cava*: The Arteries come from the *Aorta*.

Those Veins and Arteries are called *Emulgents*: They come out from the Kidneys in their hollow Sides (which lie nearest to the *Cava* and *Aorta*) included in one common *Capsula*, and are divided into several Branches, which surround the *Pelvis*. These Branches are again sub-divided into an Infinity of other lesser ones, which go to the external Parts of the Kidneys, where they inosculate, and form a kind of *Net*; from which their Extremities coming, terminate also in Infinity of Glands, which are all very small.

These Glands are in Figure roundish, and they compose the outer Substance of the Kidneys, which is half a Finger thick. From each of them there goes a long small Tube; and the Collection of these Tubes compose the innermost Substance of the Kidneys.

As these *Tubules* approach the *Pelvis*, they gather together in little Bundles; whose Extremities piercing the Membrane of the *Pelvis*, form those little Protuberances on the Inside of the *Pelvis*, or Cavity in the middle of the Kidney, which are called the *Papillæ*.

This Cavity, or *Pelvis*, is form'd by the Dilatation of the *Ureters*: It sends out several Ramifications, which divide the Urinary Tubes into Bundles, and which make a sort of *Capsula* to the Blood Vessels.

The Use of the Kidneys is to separate the Urine from the Blood; which by the Motion of



the Heart and Arteries is thrust into the Emulgent Branches, which carry it to the little Glands; by whose Means the Serosity being separated, is received by the Orifice of the little Tubes, which go from those Glands to the *Pelvis*; from whence it runs by the Ureters into the Bladder.

The Blood which was carried into the Glands, its Particles being too gross to enter into the small excretory Tubes, is brought back from the Kidneys by the Emulgent Veins, to be mingled with the other Venal Blood in the *Cava*.

The Description of the *Ureters*, *Vesica Urinaria*, *Glandulae Renales*, &c. you will find in their proper Places.

Dr. Keil, in his *Animal Secretion*, pag. 33. judges that the *Kidneys* are placed so near the Heart as they are, because Salts are Corpuscles which are strongly attracted, and have a most close Union with the Fluid of Water: For tho' the Lungs may divide the Particles of Salt one from another, yet still they firmly adhere to the aqueous Humour in which they swim; and therefore they may likewise at first be drawn off: And he thinks that the *Kidneys* could not well have been placed at a greater Distance, to have separated such a Quantity of Urine as they now do; and that not only on the account of the great Quantities of Blood they receive where they are, but likewise, if they had a more distant Situation, other Particles must have united with the Salts and aqueous Particles (as even in their present Station *some* terrestrial Particles do) and consequently the Urine could not have been distilled such as it is now, or at least but in a small Quantity.

KIDNEYS: see *Reins*.

KINGDOM, a Term used by the Chymists, who, according to their Cant in other things, call the three Orders of natural Bodies, *Animal*, *Vegetable*, and *Mineral*, by the Name of *Kingdom*.

Thus they would say, Those Bodies which belong to the *Animal Kingdom*, abound most in volatile Salt.

KING'S-BENCH, is the Court or Judgment-Seat, where the King of *England* was sometimes wont to sit in his own Person; and therefore it was moveable with the Court or King's Household, and called *Curia Domini Regis*, and *Aula Regia*, as *Gwin* reports in his *Preface to his Reading*, and that therein, and in the Court of Exchequer, which were the only Courts of the King till *Henry the Third's* Days, were handled all Matters of Justice, as well Civil as Criminal.

This Court of the *King's-Bench* was wont in ancient Times to be especially exercised in all criminal Matters and Pleas of the Crown, leaving the handling of private Contracts and Civil Actions to the *Common-Pleas*, and other Courts.

KING-PIECE in any Building, is a Piece of Timber standing upright in the middle between two principal Rafters, and having Struts or Braces going from it to the middle of each Rafter.

KINGS at Arms: See *Heralds*.

KING-SILVER, is properly that Money due to the King or Queen in the Court of Common-Pleas *pro Licentia concordandi*, in respect of a Licence then granted to any Man for passing a Fine.

KINTAL, is a Weight in Merchandise, usually of about an hundred Pounds, but something more or less, according to the different Customs of different Nations.

KIPPER-TIME, a Space of Time between the Festival of *Inventio Crucis*, May 3. and *Epiphany* or Twelfth-Day, during which Time Salmon-fishing is forbidden by *Rot. Parl.* 50 *Edward 5.* in the *Gravesend to Henley*.

KNAVE, is an old *Saxon* Word for a Man-Servant, and is so used in 14 *Edw. 3. Stat.* 1. c. 3. and *Verstegan* thinks it comes from the *Dutch Cnapa*, which signifies the same Thing. *Cnapa* in *Saxon* also is a Male-Child or Boy; and in this Sense a *Knave-Child* hath been frequently used formerly in Contradistinction to a *Girl*; and in this Sense *Wickliff* uses the Word in his Translation of *Exod.* 1. 16. and other Places of the Bible.

KNAVE-LINE, is a Rope in a Ship, fasten'd to the Cross-Trees under the Main or Fore-top, whence it comes down by the Ties to the Ramhead, and there 'tis reeved through a Piece of Wood of about two Foot long, and so is brought to the Ship's Side, and there haled up taught to the Rails.

Its Use is to keep the Ties and Hallyards from turning about one another, as they are apt to do when new and first used; and therefore after they are a little used and stretched, this *Knave-Line* is taken away, of no further Use.

KNECK, in the Sea-Language, is the twisting of a Rope or Cable as it is veering out.

KNEES, are Pieces of Timber in a Ship bowing like a Knee, which are used to bind the Beams and Futtocks together, being bolted strongly into them both.

Hence such Timber as is useful for this Purpose is called

KNEE-TIMBER: Thus the Cut-water of a Ship is called *the Knee of the Head*.

KNETTELS; so the Seamen call two Pieces of Spun-yarn put together untwisted.

KNEVELS, the same with *Kewels*.

KNIGHT, *Miles*, from the *Saxon Cnite*, signifies with us a Person that beareth Arms, and who for Valour and Martial Conduct is, by the Sovereign, or his Authority, singled from the ordinary sort of Gentlemen, and raised to a higher Step or Dignity. This among almost all Nations takes his Name from the *Horse*, because they used to serve in War on Horseback. Thus the *Romans* called them *Equites*; the *Italian* Word is *Cavallieri*; the *French*, *Chevaliers*; the *Germans*, *Reyters*; the *Spaniards*, *Gaval-lares*, &c. It appears by the *Stat.* 1 *E. 2. c. 1.* That formerly a Gentleman having a full Knights-Fee, and holding his Land by Knight-Service, might be urged by Distress to procure himself to be made *Knight* when he came to full Age: But by 17 *Car. 1. 20.* no Man can be compelled to take that Order on him. The Manner of making *Knights*, *Camden*, in his *Britannia*, shortly expresses in these Words: *Nostris vero Temporibus qui Equestrem Dignitatem suscipit, flexis genibus educto Gladio leviter in humero percutitur; Princeps his Verbis Gallicè effatur: Sois Chevalier au nom de Dieu.*

KNIGHTS *Bannerets*. See *Bannerets*.

KNIGHTS of the Bath, are an Order of *Knights* made within the Lifts of the Bath, and girded with a Sword in the Ceremony of their Creation. They are spoken of in 8 *Edw. 4. c. 2.* For their Antiquity and Manner of Creation, see *Dugdale's* Description of *Worcestershire*. They take Place of *Knights Bachelors*, and come after *Baronets*.

KNIGHTS, aboard a Ship, are two Pieces of Timber, in each of which go four Shivers, three for the Halliards, and one for the Top-Ropes. They are usually shaped into the Form of some Head; one of them standeth aft the Main-mast, and therefore is called the *Main-Knight*; the other standeth abaft the Fore-mast on the second Deck; and this is called the *Fore-Knight*.

KNIGHTS-FEE, is so much Inheritance as is sufficient yearly to maintain a *Knight* with convenient



nient Revenue; which in *Hen. III*'s Time was 15 Pounds, *Camd. Brit.* p. 111. But *Sir Tho. Smith*, in his *Repub. Anglor.* lib. 1. cap. 18. rateth it at 40 Pounds. And in *1 Edw. 2. c. 1.* it appears that such as had 20 Pounds in Fee, or for Term of Life, might be compelled to be *Knights*; but this is now repealed by *17 Car. 1.* *Stow* in his *Annals* saith, "There were in *England* at the Time of the Conquest 60211 (others say 60215) *Knights-Fees*; whereof the Religious Houses, before their Suppression, were possess'd of 28015." Some say a *Knight's-Fee* contained 8, others 12 *Plough-Lands*, or 600 Acres.

*KNIGHTS of the Garter*, are an Order first created by King *Edward III.* after the Acquisition of many great and glorious Victories. He sought out of his own Kingdom, and all over Christendom, for a Number of most excellent and noble Persons, to each of which he gave a blue Garter deck'd with Gold, Pearls, and precious Stones, with a Buckle of Gold, to be worn only on the Left Leg; a Kirtle, Crown, Cloak, Chaperon, a Collar, and other stately and magnificent Apparel. The Number was 26, of which the King and his Successors were ordain'd *Sovereigns*, and the others *Companions*, or Brethren of the most Noble Order of the *Garter*.

This most Honourable Society is now a College or Corporation, having a common Seal belonging to it; having, besides the *Sovereign*, which is Guardian of the Order, and who governs it by himself, or Deputy; and besides the 25 *Companions*, or *Knights of the Garter*, 14 Secular Canons, that are Priests, or must be within a Year after their Admission; 13 Vicars, which must also be Priests; and 26 poor Knights, that have no other Subsistence or Means of Living but the Allowance of this Order. The Bishop of *Winton*, for the Time being, is called *Prelate of the Garter*; the Bishop of *Sarum*, *Chancellor of the Garter*; the Dean of *Windsor*, *Register of the Garter*. The Principal King at Arms is called *Garter*, who is to manage and marshal their Solemnities at all Installations and annual Feasts. The *Usher of the Garter*, is also *Usher of the Black-Rod*. By Order of King *Charles I.* all the *Companions of the Garter* are to wear on the left Side of their upper Garment the Cross of *England*, encircled with the *Garter* and *Motto*, and with Rays of Silver issuing from thence every way like a Star; whence 'tis usually called the *Star and Garter*.

*KNIGHT-Marshal*, is an Officer in the King's House, having Jurisdiction and Cognizance of any Transgression within the King's House and Verge; as also of Contracts made there, whereof one of the House is Party.

*KNIGHTEN Gild*, was anciently a *Guild* in *London*, consisting of nineteen Knights, founded by King *Edgar*; who gave them a Portion of waste Ground, lying without the Walls of the City, which is now called *Port-Soken-Ward*. *Stow's Annals*, p. 151.

*KNIGHTHOOD*, a military Order or Honour, a Mark or Degree of ancient Nobility, or Reward of personal Virtue or Merit.

*Honorary KNIGHTHOOD*, is that which is conferr'd by Princes on other Princes, and also on their own great Ministers and Favourites, as that of the *Garter*, &c.

*Military KNIGHTHOOD*, is that of the ancient Knights, who acquired it by high Feats of Arms.

*Regular KNIGHTHOOD*, is that of the military Orders, who profess to wear some particular Habit, to bear Arms against Infidels, to succour and assist Pilgrims in their Passage to the *Holy Land*, and to serve in Hospitals, &c. as the Knights of *Malta*.

*Social KNIGHTHOOD*, is a Knighthood that is not fixed nor confirmed by any formal Institution, nor regulated by any lasting Statutes, such as have risen on occasion of Factions, Tilts, Tournaments, Masquerades, &c.

*KNIGHTS Errant*, a pretended Order of romantick Knights, who are storied to travel the World over in Search of Adventures, in redressing Wrongs, rescuing Damsels, and taking all Occasions to signalize their Bravery.

*KNIGHTS of the Shire*, are two Knights or Gentlemen of Worth chosen on the King's Writ *pleno comitatu*, by such of the Free-holders in every County as can expend 40 Shillings *per Annum*. Knights of Parliament.

*KNIGHT-SERVICE* was a Tenure, whereby several Lands in this Nation were held of the King, which drew after it Homage, Escuage, Wardship, Marriage, &c. but taken away by *12 Car. II. cap. 24.*

*KNOCKING-Mill*, is the same with a *Stamping-Mill*; which see, and also the Word *Tim*.

*KNOT*, [in *Botany*] a Part of a Tree or Plant, whence shoot out Branches or Roots.

*KNOT*, [with *Physicians*] a Tuberosity form'd in the Joints of old gouty People, consisting of a viscous, crude, indigested *Pituita*, accompanied with a bilious, hot, and acrimonious; the grossest and most earthy Part of which clogs and becomes a stony Substance, like Chalk.

*KNOTS*; there are two sorts of Knots used at Sea, one they call a *Bowlin-Knot*, because by this Knot the Bowlin Bridles are fastened to the *Creeper*: This is very fast, and will not slip.

The other is a *Wale-Knot*, which is a round Knob or Knot, made with three Strands of a Rope; this Knot serves for the *Top-sail-Sheets* and *Stoppers*.

The Divisions also of the *Log-Line* are called Knots: These are usually seven Fathom, or forty two Feet asunder, but they should be fifty Feet; and then as many Knots as the *Log-Line* runs out in half a Minute, so many Miles doth the Ship sail in an Hour; supposing her to keep going at any equal Rate, and allowing for Yaws, Leeway, &c. See *Log*.

*KNOWLEDGE* [according to *Mr. Locke*] consists in the Perception of the Connection and Agreement and Disagreement or Repugnancy of our Ideas. Thus we know that White is not Black, by perceiving that these two Ideas do not agree.



## L A C

**L**ABEL, is a long thin Brass-Ruler, with a small Sight at one End, and a Center-hole at the other; commonly used with a Tangent-line on the Edge of a Circumferenter, to take Altitudes, &c.

**L**ABEL, in the Law, is a narrow Slip of Paper or Parchment affixed to a Deed or Writing, in order to hold the appending Seal. So also any Paper, annex'd by way of Addition or Explication to any Will or Testament, is called a *Label* or *Codicil*.

**LABIA LEPORINA**, are such Lips as by reason of their ill Make will not come together, which some call *Rostra Leporina*; we *Hare-Lips*.

**LABIAL Letters**, are (by the Grammarians) accounted such as in their Pronunciation require chiefly the Use of the Lips to form their Sound.

**LABIATE Flowers** [in *Botany*] such Flowers as have one or two Lips, some of which resemble a kind of Helmet or Monk's Hood.

**LABORANT**, he that attends on and works under a Chymist, while he is about any Process or Experiment.

**LABORALIS**, in the Common Law, is a Writ that lies against such as having not whereof to live, yet do refuse to serve; or for him that refuseth to serve in Summer where he served in Winter.

**LABORATORY**, or *Elaboratory*, a Room fitted on purpose for Chymical Operations, and furnished with Variety of Furnaces and Instruments necessary to that Art.

**LABYRINTH**, [*λαβυρίθῳ*, Gr.] a large intricate Edifice among the Antients, cut into divers Isles and Meanders, running into each other so as to render it difficult to get out of it.

Of these Labyrinths we read of four celebrated ones in Antiquity: 1. The most famous of which was that of *Crete*, built by *Dædalus*. 2. That of *Egypt*, situate in the Lake *Myris*, which, as *Pliny* relates, was the oldest of all, which in his Time had stood 3600 Years, built by King *Petefucus* or *Tithoes*, but according to *Herodotus* was the Work of several Kings, consisting of 12 Palaces and 1500 Apartments. 3. That of *Lemnos*, which was supported by Columns of wonderful Beauty. 4. That of *Italy*, built by *Porfenna* for his Tomb.

**LABYRINTH**, is the second (some say the third) Cavity of the Ear, hollowed in the *Os Petrosum*; and is made of three winding semi-circular Pipes, which open by five Orifices into the *Vestibulum*.

**LAC LUNÆ**, or *Flores Argenti*, is the Chymists Word for a white, porous, friable Earth, insipid, but dissoluble in Water, which it will tinge with a milky Colour: It is a Sublimate from a Matter commonly found in Silver-Mines, whence the Name.

**LACERTA**, is a Word used in *Doomsday-Book*, and signifies a Fathom.

**LACERTUS**: see *Brachium*.

**LACHES**, in the Law-sense, seems to signify *Slackness* or *Negligence*, as appears from *Littleton*, *Fol.* 403 and 726, where *Laches* of Entry is nothing else but a Neglect of the Heir to enter; and so perhaps comes from our *English* Word to *Lack*; unless from the French *Lascher* or *Lasche*.

**LACHRYMÆ**, are a Moisture which is separated by the Glandules of the Eye to moisten the Eyes; which if it be too much, so that it cannot be

## L A D

received by the *Punctum Lachrymale*, it falls from the Eyes in Drops, and is called Tears.

Whatever also is strained through, and drops out naturally, or is let out by Incision, from any Part of a Plant, whether it be *Gum*, *Rosin*, *Oil*, &c. is called *Lachrymæ*.

**LACHRYMALE** *Punctum*, vel *Foramen*, is an Hole in the Nose, by which the Matter or Liquor of the Tears passes to the Nostrils. If this Hole grow hard and brawny, from an Ulcer in one of the Glandules at the Corners of the Eyes, thence arises a *Fistula Lachrymalis*.

**LACHRYMALIS** *Glandula* [in *Anatomy*] a small oblong Gland, situate above the Eye, near the little *Canthus*, whence two or three small Ducts proceed, which open on the inner Surface of the Eye-lid, and filtrate a Serosity, which serves to moisten the Ball of the Eye, and facilitates its Motion.

**LACHRYMATORIES**, were small earthen Vessels, wherein the Tears of the weeping Friends that survived, were repositied, and buried with the Ashes and Urns of the Dead.

**LACONICUM**, *Caldarium* and *Assa*, or *Balneum æreum*, was formerly a Cellar made to provoke Sweat; which was done by an hot Vapour, or a dry Heat included therein. *Blanchard*.

**LACTEAL** *Veins*, or *Vessels*: see *Vasa Lactea*.

**LACTUCIMINA**, the same that *Apthæ*.

**LACTUMIÆ**, the same that *Achores*.

**LACUNAR**, in Architecture, is an arched Roof or Cieling, more especially the Planking or Flooring above the *Portico's*.

**LACUNÆ**, are little Pores or Passages in the *Vagina* of the Womb, but no where greater than in the lower Part of the urinary Passage: There flows a certain serous pituitous Matter out of these *Ductus's*, which lubricates the *Vagina*.

**LADA**, is a *Lade* or *Lath*, from the Saxon *Lathian*, signifies an Assembly or Court of Justice; and from hence the annual Court at *Dym-Church* by *Romney-Marsh* in *Kent*, for the Election of a Bailiff and other Officers, is call'd *Dym-Church-Lath* to this Day.

**LADA**, from the Saxon *Ladian*, also signifies a Purgation by Trial; and in the Laws of King *Ethelred*, there is frequent mention of the *Lada Simplex*, *Triplex*, and *Plena*.

**LADDERS**, in a Ship, are usually three: The *Entring-Ladder* is in the *Waste*, and made of Wood. The Second is the *Gallery-Ladder*, made of Ropes, and hung over the Galleries and Stern of Ships, and are to enter by the Stern of the Ship out of the Boat, when the Weather is foul, and the Sea high. The third, *viz.* *Bolt-sprit-Ladders*, are at the *Beak-Head* made fast over the Bolt-sprit, to get upon it; and are only used in great Ships.

**LADLE**, an Instrument to load great Guns with Powder. It ought to be so proportioned, that two Ladles-full may charge the Piece: Therefore their *Breadth* must be 2 Diameters of the Shot, and their Length for double-fortified Cannon 2 and  $\frac{1}{2}$  of the Shot; for ordinary Cannon it must not exceed 2; but for Culverins and Demi-culverins it may be three Diameters of the Shot; and 3 and  $\frac{1}{2}$  for lesser Pieces, in order to load at twice: If you would load at once, this Length of the Ladle must be doubled; and observe this, that a Ladle 9 Balls in Length



Length and 2 Balls in Breadth, will hold just the Weight of the Iron-Shot in Powder.

LAFORDSWICK, in the old Saxon, is the betraying of, or Infidelity to a Lord and Master. 'Tis mentioned in the Laws of *Canutus*, c. 61. and those of *Henry I.* c. 13.

LAGA, is a Word used for Law in *Magna Charta*: And hence comes *Dane Lage*, *Saxon Lage*, *Mercen Lage*, &c. as also

LAGEDAYUM, or *Lagh-day*; that is, a Law-day, or Day of open Court: Hence also a *Lages-Man* is *Homo Legalis*; and this Word *Lage-Man* is frequently used in *Doomsday-Book*, and in the Laws of *Edward the Confessor*.

LAGEN, *Lagena*, in ancient Times was a Measure containing six *Sextarii*. Vid. *Fleta*, l. 2. c. 8, 9. and *Charta Ed.* 3. m. 25. n. 82.

LAGON or *Lagan*, is a Parcel of Goods thrown out of a Ship in a Storm, &c. and because they would else sink, they are fastened to a Buoy or Cork, in order to be found again. If the Ship be wreck'd, the Goods are called *Lagan* or *Ligan*, *quasi à Ligando*: and so long as they continue in the Sea, they belong to the Admiral; but when cast ashore they become a *Wreck*, and belong to him that hath the *Wreck*, as appears in *Co. l. 5. fol. 106*.

LAGOPHTHALMIA [*λαγοφθαλμία*, of *λαγώς* a *Hare*, and *ὀφθαλμία*, a *Disease in the Eye*] a Disease of the Eye-lids, when the upper Lid is so contracted, that the Eye cannot be quite closed, but remains open, even while Persons are asleep.

LAHSLITE, *Lagslite*, *Laghslite*, is used in the Laws of *Hen. I.* c. 13. for a Transgression of the Law, and sometimes for the Punishment thereunto belonging.

LAKE, an Inland Collection of Water, large and deep. A small Lake, neither receiving nor sending forth Rivers, I call a Pool. 1. Of those Lakes which neither receive nor send forth Rivers, the smaller, which are dried up in Summer, are either form'd by a Confluence of Rain-Water, which in *India* are often artificially made, a Mile or two in Circuit, and wall'd with Stone, to preserve the Rain that falls during the rainy Season, for Use during the dry Season of the Year; or else they are form'd by the Over-flowing of the Sea or Rivers, especially the *Nile* and the *Niger*, which are likewise often artificially made for the like Reasons. Many Lakes, the Effects of Rains, Snows, &c. and Inundations, are found in *Muscovy*, *Finland*, &c. Those Lakes without Rivers, which are never dried up, are supplied by Springs; which is more remarkably evident in such as are found on the Tops of Mountains. Nor are there many Lakes of this kind without Rivers: There are some small ones in *Muscovy* and *Finland*, *Lynchnitii* in *Macedonia*, *Apollonia* in *Mysia* (a Province of *Asia minor*), the Lake *Zirichnitz* in *Carniola* (in *Germany*), one in *China*, *Hilam* in *Conchin-china*, one in the Desert of *Azarad* in the Kingdom of *Soudan* (Part of *Sara* in *Africa*), one in *North America*, upon the Bank whereof the City *Mexico* is founded, and another not far off to the Westward. The great Lake of *Parime*, plac'd by some Geographers in *South America* under the Equator, is upon the strictest Search not to be found. Lakes sending forth Rivers, but receiving none, are innumerable in *Muscovy*, *Finland*, *Lapland*, &c. They are form'd by Springs breaking forth in Cavities of the Earth's Superficies, which Cavities when fill'd run over, and send forth Rivers; the more remarkable of which are the Lake *Chamay* in the Kingdom of *Ava* Eastward of *Ganges*, and sending forth the Rivers

*Laguia* and *Calpoum*. 2. The Lake *Samo*, near the Borders of *China*, whence one Branch of the great River *Hoanbo* running thro' that Country. 3. The Lake *Titicaca*, about 80 Leagues in Circuit, in *Peru*, sends forth a great River, which afterwards forms another small Lake and disappears. 4. The Lake of *Nicaragua* in *North America*, near the *Isthmus*, empties itself into the *Atlantic*. 5. The Lake of *Xarayes*, whence the River of *Plate*. Those Lakes which receive Rivers, but send forth none, have subterraneous Outlets, and are few in Number. 1. The small Lake, into which the foresaid Lake of *Nicaragua* flows. 2. The *Dead Sea*, or *Sea of Sodom*, which receives *Jordan*. 3. A small one in *Asia minor*. 4. The small Lake *Janna* in *Macedonia*. 5. The Lake of *Geneva*. 6. One near *Calgistan* in *Persia*. 7. The Lake *Sora* in *Muscovy*. 8. The Lake in which the River *Ghir* in the Kingdom of *Tafilot* in *Barbary* ends. Of those Lakes which both receive and send forth Rivers, the most remarkable are, 1. Those of *North America*, form'd principally by the River of *St. Lawrence*: Of all Countries, this abounds the most with large Lakes. 2. The Lake of *Dambea* in *Abassia*, form'd by the *Nile* near its Springs. The Lakes *Zaire* and *Zembre* are fabulous. 3. The Lake *Du Garde*, form'd by the River *Niger*. 4. 5. The Lakes of *Onega* and *Ladoga*, near the Confines of *Sweden* and *Muscovy*. 6. The Lake of *Enara* in *Swedish Lapland*. 7. The Lake *Ula*, in *Eastern Bothnia*, belonging to *Sweden*, with an Island in the midst. 8. Several in *China*. From Salt-Springs in their Bottoms, are caus'd several salt Lakes, viz. in *Madagascar*, *Peru*, and *Cuba*; the Sea of *Sodom*, or *Lacus Asphaltites*, rendring the adjacent Land barren, &c.

The *Caspian Sea* (improperly so called, as being no Part of the Ocean) is properly a Lake, of that kind which receives Rivers, but sends forth none. Whether the Sun exhales from it as much in Vapours, as the Rivers bring into it, (see the *Discourse of the Quantity of Vapours exhal'd*, in the Map of the World) or whether it have beside a subterraneous Communication with the Ocean, is uncertain. Its Saltness probably proceeds from Salt Rocks in the Bottom of its Channel. Probably it had once an open Communication with the Ocean; and whenever the *Bosphorus* happens to be stopp'd up, the *Black Sea* will become such another Lake.

Marshes are of two Kinds; the ouzy, consisting of mix'd Earth and Water, not bearing the Footsteps of Men; others consisting of little Pools interspers'd among Hillocks of dry Ground. The first kind sends forth no Rivers, many of 'em being found in *Ireland*, *Holland*, *Hungary*, &c. To the latter most Rivers, as the *Don*, the *Nile*, &c. owe their Rise: Many of these are found in *Finland*, and among the Forests of *Germany* and *Muscovy*, from among which the Sun is not able to exhale the Rain-Water, which stagnates. Remarkable likewise are the Marshes of *Gaoga* (lying West of *Sennar* in *Africa*) formerly call'd *Paludes Chelonides*, and those in *Chaldaea* (now *Curdestan*) thro' which *Tigris* and *Euphrates* pass.

LAMBITIVE, a pectoral Medicine, to be lick'd off the End of a piece of Licorice-stick, the same with *Eclegma*: which see.

LAMBDOIDES, is the backward Suture of the Brain, so called from its Likeness to the Letter *Λ*, *Lambda*.

LAMELIÆ, are the little thin Plates, constituted by a Net-work of very small Fibres, of which the Shells of Shell-fishes consist, or are composed.



LAMINÆ, the Plates or Tables of the Skull, being two in Number; whereof the outer is thicker and smother; but the inner more hard, and furrowed on its inner Surface.

LAMMAS-DAY, quasi *Lamb-mas*, is our first of *August*; and on this Day the Tenants which formerly held Lands of the Cathedral Church in *York*, were bound by their Tenure to bring a *Lamb* alive into the Church at High-mass.

Sepulchral LAMPS: It is said that the Antients had a Secret of making inextinguishable Lamps, of which several have been said to be found burning at the opening of Tombs, having lasted fifteen or sixteen hundred Years. Others look upon these Relations as fabulous; and others think that the Lamps were extinguished before the opening of those Tombs, but took Light afresh upon the Admission of fresh Air. Dr. *Plott* is of the Opinion that the making such Lamps is practicable, and he himself offers some Proposals for this Purpose. He supposes the *Linum Asbestinum* may do for the Wick, and that the *Naphtha* and liquid Bitumen which constantly springs into some of the Coal Mines, may answer to the Oil. He likewise proposes to make Lamps that will kindle on the letting in of fresh Air; by inclosing some of the liquid Phosphorus in the Receiver of an Air Pump, which will not, inclosed in that, shine at all; but upon the letting in the Air into the Receiver, he says, there will possibly appear as good a perpetual Lamp as some which have been found in antient Sepulchres.

LAMPADIAS, [of *λαμπάς*, Gr. a Lamp] a kind of bearded Comet, resembling a burning Lamp, being of several Shapes; for sometimes its Flame or Blaze runs tapering upward like unto a Sword, and sometimes it is double or triple-pointed.

LANCETTE, is a Chyrurgeon's little Knife, straight-pointed, two-edged; used in opening Veins, cutting of Fistula's, opening of the Fundament, Yard, or Womb that is shut.

LAND-BOC, was anciently a Charter or Deed, whereby Lands or Tenements were given or held.

LAND-CHEAP, was an old customary Fine paid either in Cattle or Money at every Alienation of Land, lying in some peculiar Manor, or Liberty of some Burgh. This Custom yet remains in *Malden* in *Essex*.

LAND-Fall, a Sea-Term, signifying to fall in with the Land: Thus when a Ship out at Sea expects to see Land in a little time, and it so happens that she doth, they say, That they have made a good Land-fall.

LAND GABLE or *Gravel*, was anciently a Tax or Rent issuing out of Land: 'Tis called in *Doomsday Census Prædialis*; and *Spelman* saith, it was a Penny for every House, being, as we now speak, a kind of Quit-Rent or Ground-Rent.

LAND-layed; they say, the Land is layed, when a Ship is just got out of Sight of the Land.

LAND-lock'd: A Ship is said to ride Land-lock'd when she is at Anchor in such a Place where there is no Point open to the Sea, so that she is safe from the Violence of Winds and Tide.

LAND-shut-in, is when another Point of Land hinders the Sight of that which a Ship came from; then they say, The Land is shut in.

LAND-To, is when a Ship lies so far off from the Shore, that she can but just ken Land; then she is said to lie Land-to.

LANDIRECTA, in the Saxons Time, were such Services and Duties as were laid on those that held Land. These were three Obligations, which from their Number were called *Trinoda Ne-*

*cessitas*, and were *Expedition*, *Burgh-bote*, and *Brig-bote*. These were not called *Servitia*, because not Feodal Services arising from the Condition of the Owners; but by this Name *Landirecta*, Rights that charged the very Land, whether possessed by Churchman or Layman.

LAND-TENANT, in the Law, is he that actually possesses the Land, and who hath it in his manual Occupation. The same with *Terre-Tenant*.

LANGUED [in *Heraldry*] a Term apply'd to such Animals which have their Tongues out of their Mouths, and being of a Colour distinct from that of the Animal.

LANGUOR [in *Medicine*] a Faintness, which may arise from a Want or Decay of Spirits, thro' Indigestion or too much Exercise, &c.

LANGREL-Shot, is a sort of Shot used at Sea; it is made of two Bars of Iron, with a Joint in the middle, by which means it can be shortened, and so put the better into the Gun; and at each End there is an half Bullet, either of Lead or Iron: when 'tis discharg'd, it flies out at length, and is of use to cut the Enemy's Rigging, &c.

LANIS de *crefcentia Walliæ traducendis absque Custuma*, &c. is a Writ that lieth to the Customer of a Port, for the permitting one to pass over Wools without Custom, because he hath paid Custom in *Wales* before.

LANO-NIGER, was a kind of base Coin in Use about the Time of *Edw. I.*

LANNIERS, or *Lanniards*, in a Ship, are small Ropes reeved into the *Dead-mens-eyes*, of all the *Shrowds* and *Chains*: Their Use is to slacken, or set taught the *Shrowds*: The *Stays* also of all *Masts* are set taught by *Lanners*. That Rope which fastens the *Stopper* of the *Halliards* to them, is also called a *Lannier*.

L'ANSPESE, is an inferior Officer subordinate to the Corporal, to assist him in his Duty, and supply his Place when he is absent: He is exempt usually from all common Duty, except the *Rounds* and *Sentinels Perdue*.

LANUGO, a Down or soft woolly Substance, which grows upon some Plants; thence called *Lanuginous Plants*.

LAPIDESCENT, that which can turn any Body into a stony Nature: Thus those Waters, which by having some stony Particles dissolved and swimming in them, do in their Course deposite them on the Leaves, Grass, Sticks, &c. that they run over, and so produce what are called Petrifications; these are properly *Lapidescent Waters*.

LAPIDIFICATION [in *Chymistry*] an Action or Operation whereby any Substance is converted into Stone. This is practised in Metals, fixed Salts and Salts of Plants. It is effected by dissolving a Metal in some corrosive Menstruum; and afterwards boiling that Dissolution into the Consistence of a Stone.

LAPIS Infernalis: see *Infernal Stone*.

LAPIS Prunellæ: see *Sal Prunellæ*.

LAPIS Medicamentosus, is made of two Ounces of Colcothar; Litharge, Alom and Bole-armoniack, of each four Ounces, mingled and put into an unglazed Pan; and then good Vinegar is poured upon it, to cover it two Fingers Height: Cover it, and let it stand two Days in Digestion; then add eight Ounces of Nitre, and four Ounces of Sal-armoniack; and setting the Pot over the Fire, evaporate all the Moisture; after which calcine the remaining Mass, and keep it for Use. 'Tis dissolved in Water when used, and is a famed Styptick. *Ctolius* gives a Description of a *Lapis Medicamentosus*, but *Lemery* prefers this before it. There



There is also a Stone called *Lapis Admirabilis*, whose Composition see in *Lemery, ult. Edit. p. 429.* Also another called, *The Philosopher's Stone*, *ibid.*

**LAPIS LAZULI**, a mineral Stone of a Blue Colour, found in Mines of Gold, Silver, and Copper; and also in Pits of Marble. When it is perfect, it is studded with little Specks or Stars of Gold; whence by some it is called *Lapis Stellatus*.

**LAQUEUS**, in Chirurgery, is a Band so tied, that if it be attracted, or pressed with Weight, it shuts up close. Its Use is to extend broken or dis-jointed Bones, to keep them in their Places when they are set, and to bind the Parts close together.

**LARBOARD**, the Left-hand Side of a Ship, when you stand with your Face to the Head.

**LARCENY**, in Law, is a wrongful taking away another Man's Goods, with a Mind to steal them; and in respect of the Thing stolen, is of two sorts; *viz. Great*, which is called *Theft simple*, where the Things stolen exceed the Value of Twelve Pence, and that is *Felony*: and *Petit Larceny*, when the Goods stolen exceed not the Value of Twelve Pence.

**LARGE**: The Seamen say a Ship goes or fails *Large*, when she goes neither before the Wind nor upon a Wind, but as it were quartering between both. Wherefore *Large*, *Quartering*, *Veering*, *Lasking*, or *Roomer*, are all of the same Signification.

**LARMIER**, a flat square Member in *Architecture*, which is placed on the *Cornice* below the *Cymatium*, and jets out farthest; being so called from its Use, which is to disperse the Water, and to cause it to fall at a Distance from the Wall, Drop by Drop, or as it were by Tears: for *Larme* in *French* signifies a Tear: see *Corona*.

**LARYNGOTOMIA** [of *λάρυγξ* and *τομή*, Gr. *a cutting*] the same with *Bronchotomia*.

**LARYNX**, is properly the Head or Top of the Wind-pipe, or *Aspera Arteria*; and it consists of Five *Cartilages*. The first Pair is called *Scutiform*, because something like a Shield, which constitutes the Protuberance in the Neck, called *Adam's Apple*: The second Pair is called *Annular*, because it is round like a Ring: The third and fourth Cartilage some reckon but one; but if the Membrane be taken off, it appears to be two, and is called *Guttulis* and *Glottis*: The fifth is called *Epiglottis*, which covers the Opening of the Wind-pipe at the Top. Its Use is in the Formation of the Voice and Respiration.

**LASH**, the Sea Word for binding up to the Ship's side, the Muskets, Buts of Water or Beer, or Pieces of Timber to make *Fishes* or spare Top-Masts; or when any thing is thus fastened to the Ship, 'tis called *Lashing*.

But the *Lashers* are properly those Ropes only which bind fast the Tackles and the Breeches of the Ordnance, when they are haled or made fast within Board.

**LASHED**, a Sea-Term, signifying *made fast*: The Carpenter ought to take Care that there be spare Yards *lashed* fast to the Ship's Sides; *i. e.* fastened there to use on Occasion.

**LASHITE**, was a common Forfeiture in the time of the *Danes*; it was 12 Ores, each Ore was about 6 *d.* Sterling. *Vid. Selden Hist. Tythes.* Tho' some say the Ore was in Value about 16 Pence, and that 15 of them made the *Libra* or Pound.

**LASKETS**, or *Latches*, are small Lines like Loops, fastened by sowing into the *Bonnets* and *Drablers* of a Ship; in order to lace the *Bonnets* to the *Courses*, or the *Drablers* to the *Bonnets*.

**LASKING**, when a Ship fails neither by a Wind, nor directly before the Wind, she is said to go *Lasking*; which is much the same as *Veering*, or going with a Quarterly Wind.

**LASSITUDE**: see *Copus*.

**LASSITUDO** *Ulcerosa*, is a Symptom usually attending the cold Fit of an intermitting Fever, consisting in a Soreness and Weariness of all the Joints and Bones.

**LAST**, in general, signifies a Burden, and particularly a certain Weight or Measure: As a Last of Pitch, Tar, or Ashes, is 14 Barrels; a Last of Hides or Skins is 12 Dozen; a Last of Cod-fish is 12 Barrels; a Last of Herrings is 20 *Cades*, or ten Thousand; a Last of Corn is 10 Quarters; a Last of Wool is 12 Sacks; a Last of Leather is twenty Dickers, and every Dicker is ten Skins; a Last of unpack'd Herrings is 18 Barrels.

**LAST**, in the Marshes of the *East of Kent*, also is a Court held by 24 Jurats, and summoned by the two Bailiffs thereof, wherein they make Orders, lay and levy Taxes, &c. for the Preservation of the Marshes.

**LASTAGE**, or *Lestage*, is a Custom exacted in some Fairs and Markets, to carry things where one will, saith *Rastall*; but sometimes 'tis taken also for the Balast of a Ship; and, as some say, 'tis properly a Custom paid for Wares sold by the *Last*.

**LAST-HEYRE**, is he to whom the Land comes by *Escheat*, for want of lawful Heirs; which is sometimes the Lord of whom the Land is held, and sometimes the King.

**LATCHES**, are those Parts of a Clock, which lock up and unlock the Work.

**LATCHES**, in a Ship, are the same with *Laskets*.

**LATERAL Equation**, in *Algebra*, is such an one which hath but one Root; whereas every Quadratick hath 2; every Cubick 3 Roots, &c. And such Equations can be determined and constructed by the Intersection of two Right Lines, which is a Composition of  $1 + 1 = 2$ . But a Quadratick cannot be determined or constructed without a strait Line and a Circle cutting each other. See *Wallis's Algebra*, p. 275. *Engl. Edit.*

**LATHE** (*Læstium*) is a great Part of a County or Shire, containing three or four Hundreds, as in *Kent* and *Suffex*. Whence the

**LATHE-REEVE**, or *Leid-grede*, or *Tything-Reeve*, was an Officer in the Saxon Government, who had Authority over the third Part of the Country, or over three or more Hundreds or Wapentakes; whose *Territory* was called a *Tithing*, or a *Leid* or *Leithen*. Perhaps the *Ridings* in *Yorkshire* are so called corruptly from *Tithings* or *Tridings*, as 'tis sometimes written. Matters that could not be determined in the Hundred Court, were brought to the *Trithing*, where the principal Men of three or more Hundreds, being assembled by the Authority of the *Lath-Reeve* or *Trithing-Reeve*, did decide and determine it; but if they did not, it went further to the County Court.

**LATION**, is the Translation or Motion of a Body from one Place to another in a Right Line; and so is much the same as *Local Motion*.

**LATISSIMUS Dorsi**, or *Anisclaptor*, or *Tersor*, is a Muscle of the Arm, which receives its first Appellation from its large Dimensions, it with its Partner covering the whole Back; the latter from the Use that is sometimes made of it: Its thin, broad, tendinous Origination is continued from the Seven Inferior Spines of the *Vertebra* of the *Thorax*, and all



all those of the Loins and superior Parts of the *Os Sacrum*, and the posterior Part of the *Os Ilium*; beginning to grow carnous as it passēs over the *Longissimus Dorsi* and *Sacrolumbus*; and in its Progress over the curvated Part of the Ribs, it receives several *Fasciculi* of fleshy Fibres arising from thence, which by their Conjunction compose a thick Body, still lessening itself in its Dimensions, as it marches towards the *Axilla*; and running over the inferior Angle of the *Scapula*, from whence sometimes does arise a fleshy Part of it; which I have observed (says M. Cowper) in those Bodies in whom the *Teres Minor* was absent, is at last inserted, by a short, but flat strong Tendon, to the *Os Humeri*.

**LATITAT**, is a Writ whereby all Men in Personal Actions are called originally to the *King's-Bench*: And it hath this Name, as supposing that the Defendant doth lurk and lie hid; and therefore being served with this Writ, he must put in Security for his Appearance at the Day. And by this Writ, a Man being brought in, is committed to the Marshal of the *King's-Bench*; in whose Custody when he is, he may be sued upon an Action in that Court.

**LATITUDE of a Place**, is an Arch of the Meridian of that Place, intercepted between its *Zenith* and the *Equator*: Or 'tis an Arch of the Meridian, intercepted between the *Pole* and the *Horizon*; and therefore called the *Poles Height*, &c. It's counted on the brazen Meridian on the Globes.

**LATITUDE**, in *Navigation*, is the Distance of a Ship from the Equinoctial, either North or South, and is counted on the Meridian: so that if a Ship sail towards the Equinoctial, she is said to *depress the Pole*; but if she sail from the Equinoctial, or from a lesser Latitude to a greater, she is said to *raise the Pole*: And whenever a Ship sails to or from the Equinoctial, either North or South, her Way gain'd thus is called her *Difference of Latitude*.

**LATITUDE of a Place**, is found at Sea by having the Sun's or any Star's Declination (by the Tables) and his Meridian Altitude; and that is found by a Quadrant or Astrolabe. Now from

the Horizon to the Zenith being 90°, if from 90° you take the Sun's Meridian Altitude, the Remainder will be the *Sun's Distance from the Zenith*. When therefore by Observation the Sun's Meridian Altitude is found, you are to consider whether the Sun hath any Declination or not: If he hath none, but moves in the Equinoctial that Day, then the Elevation of the Equator will be equal to his Meridian Altitude; and consequently his Meridian Altitude is the Co-Latitude: Subduct therefore that from 90, the Remainder is the Latitude of the Place, which will be *North*, if the Sun be on the South Part of the Meridian, and *South* when the Sun comes to the North of the Meridian. 'Tis the same thing with any Star in the Equator. When the Sun or Star hath any Declination, the Zenith Distance with that will give the Latitude; for if the Meridian Altitude and Declination be both the same way, *i. e.* both North, or both South, the Difference between them will be the Latitude of the Place, or the Pole's Height: Only observe, that if the Zenith Distance exceed the Declination, the contrary Pole will be elevated. *V. gr.* If the Declination be 23°, 30' N. and the Zenith Distance 8°, 30' N. the Latitude will be 15° N. But if the Zenith Distance be 71°, 30' S. and the Declination 20° S. the Difference will be 51°, 30' = to the Latitude, as before; only it will be *North*, because the Zenith Distance exceeds the Declination. If the Declination be *North*, and the Meridian Altitude *South*, or *vice versa*, *i. e.* one contrary to the other, then the *Sum* of the Declination and the Zenith Distance is the Latitude of the Place. Indeed sometimes the Sun or Star may have two Meridian Altitudes; as when the Altitude and Declination being the same way, the latter exceeds the former; and then the Sum of the Co-declination and the Meridian Altitude is the Height of the Pole towards which the Declination is. And you must observe, that whether the Meridian Altitude be North or South, if *that* and the Co-declination together be less than 180°, the Sun or Star will have two Meridian Altitudes in 24 Hours. See *Observation*.

# A Table of the Latitudes of many of the most Eminent Places on the Earth; together with their Differences of Meridians in Time and of Longitude in Degrees, accounted from the Meridian of Her Majesty's Royal Observatory at Greenwich, near London.

*Note*, Those Places Markt thus \* having been determined by Celestial Observations; the rest have been corrected by their Help.

Places Names.	Latitude		Diff. of Merid.		Diff. of Longit.		
	D.	M.	H.	M.	D.	M.	
<b>A</b> Capulco in Mexico	17	30	7	05	106	15	W
Agra, the Mogul's Court	28	30	5	33	83	15	E
* Aleppo in Syria	37	20	2	25	36	15	E
* Alexandria in Egypt	31	07	2	12	33	00	E
* Amiens in France	49	54	0	09	2	15	E
* Amsterdam	52	21	0	19	4	45	E
* Antwerp	51	10	0	17	4	15	E
* Avignon	43	51	0	18	4	30	E
Babylon	34	30	3	14	48	30	E

Barbadoes



# A Table of Latitudes and Longitudes, &c.

Places Names.	Latitude		D. ff of Merid.		Diff. of Longit.		
	D.	M.	H.	M.	D.	M.	
Barbadoes	13	30	3	53	58	15	W
Barcelona	41	26	0	10	2	30	E
* Batavia	6	S 15	6	43	100	45	E
* Bayon	43	29	0	06	1	30	W
Bengal	21	56	6	21	95	15	E
Bergen in Norway	61	00	0	32	8	00	E
* Bononia in Italy	44	30	0	47	11	45	E
* Boston in New-England	42	25	4	42 $\frac{1}{2}$	70	37	W
* Brest in France	48	23	0	18	4	30	W
* Bourdeaux	44	50	0	02	0	30	W
Cadiz in Spain	36	16	0	30	7	30	W
* Calais in France	50	57	0	07	1	45	E
Camboia in India	10	20	7	12	108	00	E
* Canea in Crete	35	29	1	36 $\frac{1}{2}$	24	07	E
Candia	35	18	1	41	25	15	E
* Cape Bon Esperance	34	S 15	1	19	19	45	E
* Cape Comerin	8	00	5	13	78	15	E
* Cape Verde at the Isle of Goree	14	43	1	09	17	51	W
* Cayenne, West-Indies	4	56	3	26	15	30	W
* Cayro	30	04	2	17	34	15	E
Ceylon	7	50	5	33	83	15	E
* Cheusan, China	30	00	8	06	121	30	E
Cochin, East-Indies	9	25	5	03	75	45	E
Conimbra, Portugal	40	30	0	39	9	45	W
* Constantinople	41	07	2	07	31	45	E
* Copenhagen, Denmark	55	40	0	50	12	30	E
Corvo Insula	40	03	2	06	31	30	W
Cracow, Poland	50	10	1	18	19	30	E
Cusco in Peru	12	S 25	4	55	73	45	W
* Dantzick in Poland	54	22	1	16	19	00	E
* Diep in Normandy	49	56	0	04	1	00	E
* Dublin in Ireland	53	12	0	28	7	00	W
* Dunkirk, Flanders	51	01	0	09	2	15	E
Durazzo in Dalmatia	41	58	1	21	20	15	E
* Edinburgh in Scotland	55	57	0	12	3	00	W
* Embden	53	05	0	30	7	30	E
Fero Insula	28	05	1	13	18	15	W
Fez	33	10	0	24	6	00	W
* Florentia	43	41	0	47	11	45	E
Frankford on the Maine	50	04	0	33	8	45	E
Geneva	46	22	0	26	6	30	E
Genoa	44	27	0	39	9	45	E
* Ghent	51	01	0	15	3	45	E
Greenwich at the Observatory	51	28 $\frac{1}{2}$	0	00	0	00	
Goa in India	15	30	4	55	73	45	E
* Goes in Zealand	51	30	0	16	4	00	E
* Guataloupa	14	00	4	09 $\frac{1}{2}$	62	20	W
* Grenoble	45	16	0	24	6	00	E
* Hamburgh	53	41	0	42	10	30	E
Havre-de-Grace	49	30	0	00 $\frac{1}{2}$	0	07	E
Heidelberg	49	20	0	36	9	00	E
Hoaigan in China	33	35	7	56	119	00	E
* Jamaica, Port Royal	17	40	5	04	76	00	W
Ingelstad	48	40	0	46	11	37	E
* Inspruck	47	15	0	47	11	45	E
* Kebreck, New France	47	00	4	40	70	00	W
* Koningsberg in Prussia	54	43	1	22	20	30	E
Leghorn	43	18	0	51	12	45	E
Liege	50	40	0	24	6	00	E



# A Table of Latitudes and Longitudes, &c.

Places Names.	Latitude		Diff. of Merid.		Diff. of Longit.		
	D.	M.	H.	M.	D.	M.	
* <i>Leipsick</i>	51	19	0	53	13	15	E
<i>Lima Peru</i>	12	S 20	5	24	81	00	W
* <i>Lintz, Austria</i>	48	16	1	00	15	00	E
* <i>Lions, France</i>	45	45	0	20	5	00	E
* <i>Lisbon, Portugal</i>	38	50	0	42	10	30	W
* <b>LONDON</b>	51	32	0	0 $\frac{1}{2}$	0	05	E
* <i>Macao, China</i>	22	13	7	44	116	30	E
<i>Madagascar Bay of Terra del Gada</i>	19	S 29	2	58	44	00	W
<i>Madrid, Spain</i>	40	10	0	13	3	15	W
* <i>Majorca</i>	39	35	0	10	2	30	E
* <i>Malacca, India</i>	2	42	6	40	100	00	E
* <i>Martinico Island</i>	14	44	4	04	61	00	W
* <i>Marseilles</i>	43	20	0	21 $\frac{1}{2}$	5	22	E
<i>Messina in Sicily</i>	38	21	1	06	16	30	E
* <i>Mexico</i>	20	06	6	49	102	10	W
<i>Munchen, Bavaria</i>	48	58	0	47	11	45	E
* <i>Montpelier</i>	43	36	0	15	3	45	E
* <i>Muscov</i>	55	34	2	35	38	45	E
* <i>Namur</i>	50	25	0	20	5	00	E
<i>Nangasack, Japan</i>	32	53	8	31	127	45	E
* <i>Nancy, Lorraine</i>	48	39	0	27	6	45	E
* <i>Nants</i>	47	13	0	06 $\frac{1}{2}$	1	36	W
<i>Naples</i>	41	05	1	03	15	45	E
* <i>Narbon</i>	43	15	0	09	2	15	E
<i>Narsinga</i>	18	15	5	34	83	30	E
* <i>Nice, Provence</i>	43	38	0	29	7	15	E
* <i>Ningpo or Liampo, China</i>	29	58	8	01	120	15	E
* <i>Noremberg</i>	49	29	0	49	12	15	E
<i>Olinda Brasile, or Pernambuck</i>	7	S 48	2	20	35	00	W
* <i>Oxford</i>	51	44 $\frac{1}{2}$	9	05	1	15	W
<i>Ozaca Japan</i>	35	05	8	52	133	00	E
* <i>Padua</i>	45	31	0	45	11	15	E
* <i>Paris</i>	48	50	0	09	2	15	E
* <i>Pekin, China</i>	39	55	7	51	117	45	E
* <i>Poudicherri</i>	11	54	5	21	80	15	E
* <i>Prague, Bohemia</i>	50	40	0	58	14	30	E
* <i>Ratisbon</i>	48	59	0	49	12	15	E
<i>Reggio in Italy</i>	42	15	0	55	13	45	E
* <i>Rhodes</i>	36	42	2	12	33	00	E
* <i>Rochel</i>	46	10	0	05 $\frac{1}{2}$	1	20	W
<i>Rome</i>	41	51	0	52	13	00	E
* <i>Rostock</i>	54	10	0	51	12	45	E
* <i>Roterdam</i>	51	55	0	17	4	15	E
<i>Salamanca, Spain</i>	41	12	0	16	4	00	W
* <i>Seville</i>	37	36	0	26	6	30	W
* <i>Siam in India</i>	14	18	6	43	100	45	E
* <i>Smirna in Ionia</i>	38	28	1	49	27	15	E
<i>Spahan, Persia</i>	36	14	4	20	65	00	E
<i>Stockholm, Sweden</i>	58	50	1	10	17	30	E
<i>Syracusa, Sicily</i>	37	04	1	01	15	15	E
<i>Tangier</i>	35	55	0	25	6	15	W
<i>Tidore</i>	00	36	6	37	99	15	E
<i>Toledo, Spain</i>	39	46	0	14	3	30	W
* <i>Tboulon, France</i>	43	06	0	23	5	45	E
* <i>Tripoly in Barbary</i>	32	54	0	52	13	00	E
* <i>Tubing, Germany</i>	48	34	0	37	9	15	E
* <i>Valentia, Spain</i>	39	30	0	03	0	45	E
<i>Venice</i>	45	18	0	50	12	30	E
* <i>Vienna</i>	48	22	1	09	17	15	E



Places Names.	Latitude.		Diff. of Merid.		Diff. of Longit.		
	D.	M.	H.	M.	D.	M.	
<i>Upsal</i>	59	00	1	12	18	00	E
* <i>Uraniburg</i>	55	54	0	51	12	45	E
* <i>Utrecht</i>	52	05	0	20	5	00	E
* <i>Wirtemberg, Saxony</i>	51	53	0	52	13	80	E
<i>Wolfenbuttle</i>	52	11	0	44	11	00	E
<i>York</i>	54	00	0	04	1	00	W

*Note*, That those Places against which the S is placed in the Column of Latitudes, are South of the *Equator*; and all the other North.

**LATITUDE** of a *Star* or *Planet*, is its Distance from the *Ecliptick*, being an Arch of a Circle of Longitude, reckoned from the *Ecliptick* towards its Poles.

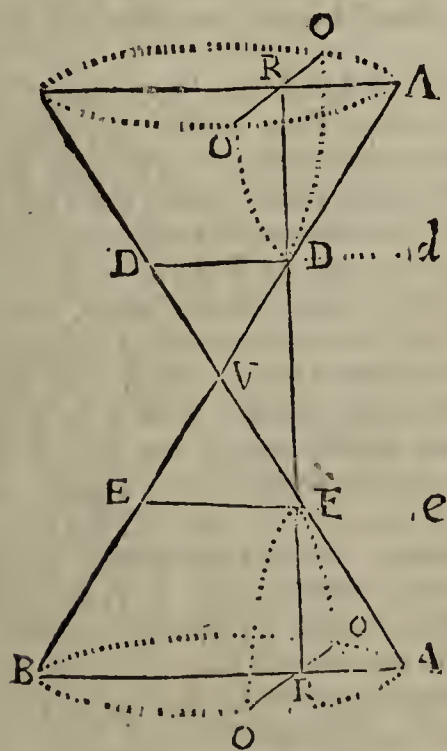
**LATITUDE** *Heliocentrick* of a *Planet*: See *Heliocentrick*.

**LATROCINIUM**, in some old Charters, is used for the Liberty of *Infang-thief*, or the Privilege of adjudging and executing Thieves.

**LATTA**, is a *Lathe* or *Tithing*.

**LATUS** *Rectum*, a Term in Conicks, being the same with *Parameter*; which see.

**LATUS** *Transversum* of the *Hyperbola*, is a Right Line lying between the Vertexes of the two *Opposite Sections*; or that Part of the common Axis which is between the Vertexes of the upper and lower Cone, as the Line *ED* in the following Figure; where also *Dd* and *Ee* may be the *Parameters*, or *Latus Rectums*, belonging to the two opposite Sections *GLRO*, and *OEO R*.



To this *Latus Transversum* answers the longest Diameter in the *Ellipsis*, which *Apollonius* calls the *Transverse Axis* or *Diameter*.

**LATUS** *Primarium*, is a Right Line belonging to a *Conick Section*, drawn thro' the Vertex of the *Section* of the *Cone*, and within it; as the Line *EE* or *DD* in the preceding Figure.

**LAVAMENTUM**, the same with *Fobus*.

**LAUDANUM**, is meant only of a Medicine made of an *Opiate*, and that they call an *Opiate Laudanum*, from its excellent Qualities. 'Tis an Extract of the finer and purer Part of *Opium*, made with Water and Spirit of Wine, and then evaporated to its due Consistence: Of this there are many ways,

but *Lemery's* seems the best: See his *Course of Chymistry*, last Edit. p. 618.

**LAUDIMIUM**, in the Civil Law, is the 50th Part of the Value of Land or Houses paid by the Proprietor to the new Tenant, by way of *Emphyteusis*, as an Acknowledgment upon *Investitures*, or for being put into Possession.

**LAUDUM**, was formerly used for an Arbitration or decisive Sentence of any chosen Judge or Arbitrator.

**LAUNCH**, in the Sea-Phrase, is to *put out*: Thus they say, *Launch* a Ship out of the Dock, or out of the Key; *Launch* the Boat, *Launch* the *David* in or out; *Launch* out the *Capstan Bars*. Also when they have hoisted up a Yard high enough, they say, in another Sense, *Launch ho!* that is, Hoist no more. Also in stowing any thing in the Hold of a Ship, they cry, *Launch aft*, or *Launch forward on*: So when they are pumping, if the Pump sucks, they say, *Launch ho!* that is, Pump no more.

**LAUNDER**, is a Trench cut in the Floor, 8 Foot long and 10 Foot over, with a Turf for a Stopper at one End, to let the Water (which comes along with the bruised Ore from the Coffer of a stamping Mill in the Tin-works) run away while the Ore sinks to the bottom. See *Tin*.

**LAURETS**, were Pieces of Gold coined in the Year 1619, with the King's Head laureated on them. There was a 20 s. Piece mark'd with xx; one of 10 s. marked x, and one of 5 s. marked v.

**LAW**. In *England* our *Laws* have been variable. (1.) We had the Laws of *Molmutius*, which were translated out of *British* into *English* by *Gildas*; of which there are some Remains in our present *Laws*. *Vid. Mag. Chart. c. 1. and 14.*

(2.) There was the *Merchen Lage*, mentioned in *Camden's Brit. and Polyd. Hist. Angliæ, lib. 5.*

(3.) *West-Saxon Lage*.

(4.) *Dane-Lage*; all which were reduced into one Body by *Edward the Confessor*.

At present the *Law* of *England* is divided into three Parts.

(1.) The *Common Law*, which is the most ancient and general.

(2.) *Statutes*, or *Acts of Parliament*.

(3.) Particular Customs. *C. on L. fol. 15.*

**LAW** hath also a special Signification, sometimes implying that which is *lawful* with us, and not elsewhere, as *Tenant by Courtesy* of *England*, 13 E. I. 3.

To *wage Law* (*vadiare Legem*) is to put in Security: To *make Law* (*facere Legem*) at a Day assigned: And to *make Law* is to make Oath that he owes not the Debt challenged at his Hands; as also to bring with him so many Men as the Court shall assign, to avow upon their Oath, that they believe in their Consciences he hath sworn truly.



And this *Law* is used in Actions of Debt without Specialty; as also, where a Man coming to the Court after such a time, that his Tenements have been seized for Default, shall deny himself to have been summoned.

*LAW of Arms, Jus Militare*, is the allowed Rules and Precepts concerning War; to make and observe Leagues and Truces, to punish Offenders in Camps, &c.

*LAW of Merchants, Lex Mercatoria*, is a Privilege or special *Law*, differing from the *Common Law* of England, proper to Merchants, and summary in Proceedings. *Vid.* 27. E. 3. Stat. 8, 9, 19, 20. 13 E. 1. Stat. 3. *Coke on Littleton*, fol. 182.

*LAW Spiritual*, is the Ecclesiastical *Law*, allowed by the Laws of this Realm, so far as it is not contrary to the *Common Law*, nor the Statutes and Customs of the Realm. According to this the Ordinary or other Ecclesiastic Judges do proceed in Causes within their Cognizance. *Coke on Littleton*, fol. 344.

This was called the *Law Christian*, and the Court the *Court Christian*; and the Rural Dean, who was Judge or President of the Court within his own District, was called hence *Decanus Christianitatis*; and in Contradistinction to this, the *Common Law* was by some called *Lex Mundana, Terrena, &c.*

*LAW of the Staple*, is the same with the *Law of Merchants*.

*LAW of Marque* (see *Reprisals*). This Word is used 27 E. 3. Stat. 2. c. 22. and comes from the German Word *March*, which is a *Bound* or *Limit*; and those who are driven to *Reprisals* are forced to take the Ship and Goods of the Injurer, since they cannot meet him at home to have ordinary Justice.

*LAW-day*, is otherwise called the *View of Frank Pledge* or *Court-Leet*; and is used for the County Court, 1 E. 4. c. 2. and indeed the *Lage-day* or *Law-day*, formerly was any Day of open Court; and was commonly used for the more solemn Courts of a County or Hundred.

*LAW-less Court*. On *King's-Hill* at *Rochford* in *Essex* on *Wednesday-Morning* next after *Michaelmas Day*, at Cock-crowing, is held a Court so called, because 'tis held at a lawless or unlawful Hour: They whisper, and have no Candle, nor any Pen and Ink, but only a Coal: And he that owes Suit or Service and appears not, forfeits double every Hour he is missing. This Court belongs to the Honour of *Raleigh*, and to the Earl of *Warwick*.

*LAWES*, are round Heaps of Stone, being a kind of rude Monument for the Dead. They are so called on the Borders between *England* and *Scotland*.

*LAWS of Motion*: see *Motion*.

*LAXATIVES*, or *loosening Medicines*, are those which, with their benign Particles, softning and scouring the Intestines, cleanse them of their Excrements.

*LAY the Land*, a Sea Phrase, which is used for sailing out of Sight of Land; for then they say, they have *laid the Land*: And if another Point of Land exclude the Sight of a former, they say, they have *shut the first Land in*.

*LAYERS* [in *Horticulture*] the low Branches of Shrubs or Trees, which are cover'd with good Mould, when the Kind is designed to be raised from them, leaving the Ends of them out till they have taken Root; after which time they are to be cut off.

*LAYMAN*, among the Painters, is a Statue of Wood, whose Joints are so made that it may be put into any Posture; and its chiefest Use is for the

casting and adjusting of *Draperies* for the cloathing of Figures.

*LEA of Yarn*. By Stat. 22, 23 Car. 2. c. — a *Lea* of Yarn at *Kidderminster* is appointed to contain 200 Threads, on a Reel which is four Yards about.

*LEAD*. The Lead Mines in *Somersetshire* are at *Mendip*, which is a Place all mountainous, but the Hills are of unequal Heights; 'tis barren and cold, and in some Places rocky: The Ridges of the Hills run confusedly, but most *East* and *West*, and not many parallel one with another. The Surface is heathy, ferny, and furzy; it feeds Sheep all the Year, and young Beasts, Horses, and Colts at Spring and Fall. The Soil is red and stony, but no way *Clayey, Marly, or Chalky*. The Stones are either of the Nature of Fire-stones or Lime-stones. The Trees have their Tops burnt, and their Leaves and their Outfides discoloured and scorched with the Wind; and they grow to no considerable Bigness. The Stones which are wash'd out by the Brooks and Springs are reddish and ponderous. The Country is more troubled with Thunder and Lightning, Storms, nocturnal Lights, and fiery Meteors, than other Parts of the County.

When they have gotten the Ore, they *beat* it small, then *wash* it clean in a running Stream, and then sift it in Iron Rudders, after which they make an *Hearth* or *Furnace* either of Clay or Fire-stone, which they set in the Ground, and upon it build their Fire, which is lighted with Charcoal, and continued with young oaken Gads: 'Tis blown with Bellows by Men's treading upon them, and after the Fire is lighted, and the Fire-place hot, they throw their Lead-Ore upon the Wood, which melts down into the Furnace; and then with an Iron Ladle they take it out, and on Sand cast it into what Form they please. *Phil. Transf.* N. 28.

In *Phil. Transf.* N. 39, you have this further Account.

The Veins of Lead have been found to run up into the Roots of Trees without apparently altering them. White, yellow, and mix'd Earth are *Leaders* to the Country or Place where the Ore lies; and changeable Colours do always encourage their Hopes. Sometimes they dig 12 Fathom deep before they meet with any Stones; other while, when a *stony Reak* is at top, they meet Ore just under the *Sward* or Surface of the Grass; which Ore hath gone down 40 Fathom. A *black Stone* is an ill Sign, and leads to *Jam*, as they call it, that is, a thick Bed of Stone that hinders their Work; a grey, clear, and dry one they account the best. They seldom meet with any *Damps*. If in sinking they come to wet moorish Earth, they expect a *Jam*, and to be closed up with Rocks. Their Nearness to the Ore they guess by short brittle Clay; for they don't think or find a tough Clay to be *leading*, as they call it; that is, directing towards Ore.

Sometimes the Ore lies *shole* or shallow, and then it is 14 or 20 Fathom, more or less, before they hit it. They follow a Vein inclining to some Depth, when it runs away in little flat *Binns*.

When the Stones part it, then they find a Vein again. Their Draughts are 14 or 20 Fathom, till they come to a Stone, where they cast a Side-Draught, called a *Cut*. Then they sink *plumb* again 4 or 5 *Cuts* one under another: They find Ore at 50 Fathom. Their best *Reaks* are North and South; East and West are good, tho' not so deep. The *Groove* is 4 Foot long, and 2  $\frac{1}{2}$  Foot broad, till they meet with Stone, and then they carry it as they can. The *Groove* is supported by Timber; a Piece as big as one's Arm will support 10 Tun of Earth.

The



The Timber there lasts long; they have known it lie 200 Years, and after that it will serve in new Works; it is tough and black, and being exposed a few Days to the Sun and Wind, grows so hard that an Axe will scarce cut it.

For the Supply of Air, they have Boxes of *Elm*, exactly closed, of about 6 Inches in the Clear, by which they carry it down 20 Fathom and more; but when they come at Ore, and need an *Air-shaft*, they sink it 4 or 5 Fathom distant, of the same Fashion with a *Groove*, to draw as well Ore as Air.

They make use of *leathern Bags*, holding 8 or 9 Gallons a-piece, to free them from Water, which are drawn up with Ropes. If they find a *Swallet*, they drive an *Adit* upon a level till it is dry. If they cannot cut the Rock, they use Fire to *anneal* it, laying on Wood and Coal, and contriving the Fire so that they can leave the Mine before Operation begins; and they find it dangerous to enter again before it be quite cleared of the Smoak, which hath killed some.

Their Beetles, Axes, and Wedges, &c. unless so hardened as to make a deep Impression on the Head of an Anvil, are not fit for their Use; and yet they sometimes break them in an Hour; others last three or four Days, as it happens. They work in Frocks and Waistcoats, by Candle-light (of Tallow) 14 or 15 to the Pound, each of which lasts three Hours, if they have Air enough. A Vein being lost, they drive two or three Fathom in the *Breast*, as the Nature of the Earth directs them. They hand out their Materials in *Elm Buckets* drawn by Ropes; the Buckets hold about a Gallon. Their Ladders are of Ropes.

The Ore sometimes runs in a Vein, and sometimes is dispersed in *Banks*; it lies often between Rocks: Some of it is hard, some milder. Many times they have *branched Ore* in the *Spar*. About the Ore there is a *Spar* and Chalk, and another Substance which they call *Crootes*, which is a mealy white Stone matted with Ore, and soft. The *Spar* is white, transparent, and brittle like Glass; the Chalk white, and heavier than any Stone. The Vein lies between the Coats, and is of different Breadths; it breaks off sometimes abruptly in the Earth, which they call a *deading Bed*; and after a Fathom or two may come again to keep the same Point. It terminates sometimes in a Rock called a *Fire-stone*, and sometimes in a dead Earth, clayey without either *Croote* or *Spar*. The clearest and hardest Ore is the best, of which 36 Hundred Weight makes about a Tun of Lead.

The Hearth for melting the Ore is about 5 Foot high, set on Timber, to be turned about as a Windmill, to avoid the Smoak on a shifting Wind: It holds half a Bushel of Ore and Coal. There is a Sink on the side of the Hearth, into which the Lead runs, and it holds about 1½ Hundred. They have a Bar to stir the Fire, a Shovel to throw it up, and a Ladle heated red hot to cast out the melted Metal. Once melting is enough, and the best, which is the heaviest, melts first. There is a *Flight* (as they call it) or Steam in the Smoak, which falling on the Grass, poisons those Cattle that eat of it. The Workmen find the Taste of it (when the Smoak flies in their Faces) to be sweet upon their Lips; brought home and laid in their Houses it kills Rats and Mice. What of this *Flight* falls upon the Sand, they gather up to melt on a *Flag-Hearth*, and make *Shot* and *Sheet Lead* of it.

LEAD, at Sea, signifies a Plummet of that Metal of about a Foot long, and six or seven Pound Weight, which is hung at the End of a long String

to sound the Depth of the Sea withal: Therefore their Word is, *Heave the Lead*, that is, sound the Depth of the Water, to know whether it be safe for the Ship to venture in any further or not.

LEAD-Nails, are such as are commonly used to nail down Lead, Leather, or Canvas to hard Wood.

LEAGUE, an Extent of Ground in Length, by which Distances from one Place to another are measured, containing Geometrical Paces more or less, according to the different Usages and Customs of Countries.

A League at Sea contains 3000 Geometrical Paces, or 3 *English* Miles; a *French* League contains the same, and in some Places 3500 Paces. The mean or common League consists of 2400 Paces, and the little League of 200. The *Spanish* Leagues are larger than the *French*: 17 *Spanish* Leagues make a Degree, or 20 *French* Leagues, or 69½ *English* Statute Miles. The *Dutch* and *German* Leagues contain each 4 Geographical Miles.

The *Persian* Leagues are pretty near of the same Extent with the *Spanish*; that is, they are equal to 4 *Italian* Miles, which is pretty near what *Herodotus* gives the Length of the *Persian Parasanga*, which contained 30 *Stadia*, 8 whereof, according to *Strabo*, make a Mile.

LEAP-YEAR, or *Bissextile*, is every fourth Year, and so called from its *Leaping* a Day more that Year than in a Common Year: For in the Common Year any fixed Day of a Month changeth successively the Day of the Week; but in the *Leap-Year* it skips or *leaps* over one Day.

Note, The Common Year hath 365 Days in it, but the *Leap-Year* 366; and then *February* hath 29 Days, which in Common Years hath but 28.

To find the *Leap-Year* you have this Rule:

Divide by 4; what's left shall be,  
For *Leap-Year* 0; for *past*, 1, 2, or 3.

Example.

In the Year 1731, what is it, a Common Year, or a *Leap-Year*?

4) 1731 (432

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13

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11

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3 Remainder; so that it is the third Year after the *Leap-Year*.

LEASE, in Law, signifies a Demise or letting of Lands or Tenements, Right of Common, Rent, or any Hereditament unto another, for Term of Years or Life, for a Rent reserved; and is either written, called a *Lease by Indenture*, or a *Lease Parol*. The Party that letteth this *Lease* is called the *Lessor*; and the Party to whom it is lett is the *Lessee*. And a *Lease* hath in it six Points: 1. Words sufficient to import a Demise. 2. A *Lessee* named. 3. A Commencement from a Day certain. 4. A Term of Years. 5. A Determination. 6. A Reservation of Rent.

LEAVER: see *Lever*.

LEAVES, are the *Notches* of the *Pinion* of a Watch: see *Pinion*.

LEAVES, in *Architecture*, an Ornament of the *Corinthian Capital*, and thence borrowed into the *Composite*. It consists in the Representation of a



double Row of *Leaves*, that covers the Vase, *Tympanum*, or Neck of the Column. The *Leaves* are commonly made in Imitation of the *Acanthus*, and sometimes of those of the *Olive-tree* or *Laurel*. The *Leaves* are divided, each making 3 Ranges of lesser, and are bent at the top one Third of their Height.

LEDGES in a Ship, are small Pieces of Timber lying athwart Ships, from the *Waste-Trees* to the *Roof-Trees*, which serve to bear up the *Nettings*, or the *Gratings* over the Half-Deck.

LEE, a Word diversly used at Sea; they mean generally by it, the Part opposite to the Wind: Thus the

LEE-Shore, is that on which the Wind blows; and therefore to be under the *Lee of the Shore*, is to be close under the Weather-shore, or under Wind. When they say,

A-LEE the Helm, they mean, put the Helm to the *Leeward* Side of the Ship. They say also, Take care of the

LEE-Latch; which is a Word of Command to the Man at the Helm, spoken by him that commands, or *Cons*, to take care that the Ship don't go to the *Leeward* of her Course: Wherefore they call a

LEEWARD Ship, one that is not fast by a Wind, or which doth not sail so near the Wind, nor make her Way so good as she should.

To lay a Ship by the *Lee*, or to *come by the Lee*, is to bring her so, that all her Sails may lie flat against her Masts and Shrouds, and that the Wind may come right upon her Broad-side. The way to do which, if all a Ship's Sails be abroad, is to bear up the Helm hard to Windward, to let rise the Fore-tack, veer the Main-sheet, and take in the Mizen-mast, or at least to *peek* it up; which is called *Spelling the Mizen*.

LEE-Way, of a Ship at Sea, is the Angle made by the Line on which the Ship should run, according to her Course or the Point of the Compass steer'd upon, and the real Line of the Ship's Way; for all Ships are apt to fall a little to *Leeward*, or to make some *Lee-way*. Wherefore in casting up the Log-board, something must always be allowed for *Lee-way*; and they give such Rules as these: 1. If the Ship be *upon a Wind*, you must allow one Point for *Lee-way*. 2. If the Wind blow hard, so that you are forced to take in one Top-sail, allow two Points for the *Lee-way*. 3. If it blow so hard that both Top-sails must be taken in, and the Sea runs high, then allow three Points for the *Lee-way*. 4. If her Fore-sail being furled, she *try* under a Main-sail and Mizzen, she will make her way four Points before the Beam. 5. If she *try* with a Main-sail only, she will make her Way near three Points before the Beam. But, 6. If under a Mizzen only, she will make her Way about two Points before the Beam.

LEE-Fang, is a Rope in a Ship, reeved into the *Crengles* of the Courses, when the Bottom of a Sail is to be haled in, that so the Bonnets may be laced on; this Rope is also of use to take in the Sail.

LEET, and Court-Leet, is a Court out of the Sheriff's Turn, and enquires of all Offences under the Degree of High-Treason that are committed against the Crown and Dignity of the King. But those Offences which are to be punished with Loss of Life or Member, are only enquirable there, and to be certified over to the Justices of Assize.

LEETCH of a Sail, (aboard a Ship) signifies the outward Edge or Skirt of the Sail from the Earing to the Clew; or rather the middle of the Sail between these two.

LEETCH-LINES, are small Ropes fastened to the *Leetch* of the Top-sails (only) and then reeved into a Block at the Yard, just by the Top-sail Ties. Their Use is to hale in the *Leetch* of the Sail, when the Top-sails are to be taken in; which is always first done, and then the Sail can be taken in with the greater Ease.

LEGACY, in Law, is a particular thing given by a last Will and Testament: For if a Man transfer his whole Right or Estate upon another, that the *Civilians* call *Hereditary*; and he to whom it is so transferred, they call *Heres*; but in Common Law he is called *Heir* only, to whom all the Man's Lands and Hereditaments descend by Right of Blood: The former is *Heres factus*, the latter *Heres natus*. But in the Ecclesiastical Sense it was formerly a *Soul-Scat*, or a Legacy given to the Church, or accustomed Mortuary.

LEGALIS homo [in Law] a Person who has not been out-law'd, excommunicated, or defamed, but stands *rectus in curia*. L. Hence

LEGALITY [in Law] is the Condition of a *legalis homo*.

LEGAN: see *Flotson*.

LEGEND [with *Antiquaries*], the Words or Letters engraven or stamp'd about the Edges, &c. of Medals, Coins, &c. as the Legend of some of our Coins is, *Posui Dominum adiutorem meum*; and that of some of the *Constantinopolitan* Emperors, *IHS XRS NIKA*, i. e. *Iesus Christ overcomes*.

LEGION. In the time of the Romans first War in Sicily, *Polybius*, lib. 1. saith, that the Roman Legion consisted of 4000 Foot and 300 Horse; afterward L. *Æmilius* and C. *Atilius Coff.* their Legion (in the great Preparations they made against the *Gauls*) consisted of 5200 Foot and 300 Horse.

After this, some Time before the Battel at *Cannæ*, the Roman Legion had in it 5000 Foot and 300 Horse, to which was added an equal Number of *Latin* Auxiliary Foot, and for the most part thrice the Number of Horse. *Polyb. lib. 3.*

LEGS of the *Martnets*, is the Term for those small Ropes in a Ship, which are put thro' the Bolt Ropes of the Main and Fore-sail, in the *Leetch* of each. They are above a Foot in Length, and at either End are spliced into themselves: They have also a small Eye, into which the *Martnets* are fasten'd by two *Hitches*, and the End is seized into the standing Part of the *Martnets*.

LEGS of a Triangle: When one Side of a Triangle is taken as a Base, the other two are called *Legs*.

LEGUMEN, in Botanicks, is that Species of Plants which we call Pulse; and they are so nam'd because they may be gather'd by the Hand without cutting. Mr. Ray reckons all those Plants which have a *Papilionaceous* or Butter-fly-like Flower, among the *Legumina*.

LEMMA, is a Term used chiefly by Geometrick Writers, and signifies a Proposition, which serves previously to prepare the way for the more easy Apprehension of the Demonstration of some Theorem, or for the Construction of some Problem. Thus to prove that a Pyramid is  $\frac{1}{3}$  of a Prism or Parallelopiped of the same Base and Height with it, (the Demonstration of which, after *Euclid's* way, in Lines, is a little difficult to conceive) we may premise this Lemma, which you will find proved under the Word Progression, That the Sum of a Series of the Squares of Numbers in Arithmetical Proportion, beginning from 0, and going on in the natural Order; as 0, 1, 4, 9, 16, 25, 36, &c. is always subtriple of the Sum of as many Terms equal to the



the greatest; or, in other Words, is always  $\frac{1}{2}$  of the greatest Term multiplied by the Number of the Terms.

Thus also to find the Inflection of a Curve Line, (if it hath any Inflection) this Lemma must be first premised, That a Tangent may be drawn to the given Curve in a given Point.

LENIENTIA, the same with *Laxantia*.

LENITIVE, [in Pharmacy] a softening, resolutive Remedy, that moistens the Part affected, and dissipates any sharp Humour that is collected there.

LENO and *Linon*, is that Part of the Brain called *Torcular Herophili*, that Place where the third Cavity of the *Dura Meninx* is joined to the first, second, and fourth.

LENS, in *Dioptricks*, is any Glas (not very thick) which either collects the Rays of Light into a Point, in their Passage through it, or disperses them further apart, according to the Laws of Refraction. Lens's have various Figures; that is, are terminated by various Surfaces, from which they acquire various Names. Some are plane on one Side, and convex on the other; others convex on both Sides; both which are ordinarily called *convex Lens's*: Tho' when we speak accurately, the former is called *plano-convex*. Again, some are plane on one side, and concave on the other, and others are concave on both sides, which are both usually rank'd among the concave Lens's; tho' when distinguished, the former is call'd a *plano-concave*. Others again are concave on both Sides; others are concave on one Side, and convex on the other, which are called *convexo-concave* or *concavo-convex* Lens's, according as the one or the other Surface is more curve, or a Portion of a less Sphere. It is to be here observed, that in every Lens terminated in any of the forementioned manners, a Right Line perpendicular to the two Surfaces is call'd the Axis of the Lens: Which Axis, when both Surfaces are spherical, passes thro' both their Centers; but if one of them be plane, it falls perpendicularly upon that, and goes thro' the Center of the other.

For *Convex Lens's*, the Laws of their Refraction, and their Effects depending thereon, are as follow:

A Ray of Light *EG* (Plate 3. Fig. 25.) near the Axis and parallel thereto, striking on the plane Surface of a plano-convex Lens, directly opposite to the luminous Body, after Refraction concurs with the Axis in the Point *F*; and if *C* be the Center of the Convexity, *CF* will be to *CL*, that is, the Distance of the Centre from the Point of Concourse or Focus, will be to the Distance of the Centre from the convex Surface, in the Ratio of the Refraction. See *Refraction*.

For the plane Surface being directly opposed to the luminous Body, the Ray *EG* is perpendicular to *AB*, and therefore will pass unrefracted to *H*: Thus it strikes on *AHB* still parallel to the Axis; and therefore coming out of a denser Medium into a rarer, will meet the Axis of the Lens in *F*, and so as that *CF* will be to *CL* in the Ratio of the Sine of the refracted Angle to the Sine of the Angle of Inclination: As will be demonstrated under the Head *Refraction*.

Cor. If then the Refraction be out of a Glas Lens into Air,  $CF:CL::3:2$ , and therefore  $FL=2CL$ . That is, parallel Rays near the Axis will concur with it at the Distance of the Diameter. Again, if the Refraction were out of a Water Lens, i. e. out of a plano-convex Lens fill'd with Water,  $CF:EL=4:3$ , and therefore  $EL=3CL$ , i. e. parallel Rays near the Axis will concur with it at the Distance of half the Diameter. So that if a

lighted Candle be placed in the Focus of a plano-convex Lens, that is, in the Point *F*, distant from the Surface of the Lens *ALB*, by the Length of the Diameter, and from the Surface of the Water Lens by half the Diameter, its Rays after Refraction will become parallel. See *Refraction*.

If the Ray *KI* (Plate 3. Fig. 26.) near the Axis of a plano-convex Lens, and parallel thereto, strike on its convex Surface *AHB*, after a double Refraction it will meet the Axis in *F*; so as that *HG* will be to *GC*, and *GE* to *FH* in the Ratio of the Refraction.

For the Ray *KI*, parallel to the Axis *EG*, by virtue of the first Refraction in *I*, will tend to the Point *G*, so as *GH* will be to *GC* in the Ratio of the Sine of the Angle of Inclination to the Sine of the refracted Angle: Therefore by virtue of the second Refraction in *L* it will concur with the Axis in *F*, so as *GD* will be to *ED* in the Ratio of the Sine of the refracted Angle, to the Sine of the Angle of Inclination: So that the Semidiameter and Thickness of the plano convex Lens, with the Ratio of Refraction, being given, hence arises a Method of determining the Focus of parallel Rays striking on the convex Surface. For

Hence, if the Lens be Glas,  $FD=2CH-\frac{2}{3}HD$ . So that if two Thirds of the Thickness of the Lens be inconsiderable (as in Practice it usually happens) parallel'd Rays meet with the Axis at the Distance of the Diameter from the Lens, even when they strike on the convex Surface.

So that as to the Place of the Focus, 'tis the same thing whether the plane Surface or the convex one be turned to a Luminary of parallel'd Rays; tho' it appears both from Experience and trigonometrical Calculation, that there are more Rays united in a less Space, if the convex Surface, than if the plane one be turn'd towards the Sun.

If the Lens were full of Water,  $FD=3CH-\frac{3}{4}HD$ . Wherefore if  $\frac{3}{4}HD$  be inconsiderable,  $FD=3CH$ ; or if  $\frac{1}{4}HD$  be inconsiderable,  $FH=3CH$ . Parallel and near Rays therefore are united at the Distance of half the Diameter, if the Refraction be in Water, even when the convex Surface is opposed to the luminous Body. Hence also arises a Method of determining the Focus of parallel Rays striking on a Lens convex on both Sides, the two Semidiameters and the Thickness of the Lens being given.

On these Principles is founded the Structure of refracting Burning-Glasses; the Sun's Light and Heat being exceedingly augmented in the Focus of a Lens, whether convex or plano-convex; since the Rays falling parallel to the Axis of the Lens are reduced into a much narrower Compass; so that 'tis no Wonder they burn some Bodies, melt others, and produce other extraordinary Phenomena. See *Burning-Glass*.

If a luminous Body be placed in the Focus behind a Lens, whether plano-convex or convex on both sides, or whether equally or unequally, the Rays after Refraction become parallel.

Hence by means of a convex Lens, or a little Glas Bubble full of Water, a very intense Light may be projected to a vast Distance. See *Mirror*.

And this furnishes us with the Structure of a Lamp or Lanthorn, to project an intense Light to an immense Distance: For a Lens convex on both sides, being placed opposite to a concave Mirror; if in the common Focus of both be placed a lighted Candle or Wick, the Rays reflected back from the Mirror to the Lens will be parallel to each other, and after Refraction will converge, till they arrive at the Distance of the Semi-diameter, after which they



they will again diverge. But the Candle being likewise in the Focus of the Lens, the Rays it throws on the Lens will be parallel: And therefore a very intense Light meeting with another equally intense, at the Distance of the Diameter from the Lens, the Light will be surprizing; and tho' it afterwards decrease, yet the parallel and diverging Rays going a long way together, it will be very great at a very great Distance. Lanthorns of this kind are of considerable Service in the Night-time to discover remote Objects, and are used with Success by Fowlers and Fishermen, to gather their Prey together in order to take them.

If it be required to have the Light at the same time transmitted to several Places, as through several Streets, &c. the Number of Lens's and Mirrors is to be increased.

If the luminous Body placed in the Focus be of a large Extent, the Rays flowing from Points sensibly distant from each other, can't be parallel, but will constitute several Trains or Pencils of Rays parallel to each other.

The Images of Objects opposed in any manner to a convex Lens, are exhibited invertedly in its Focus.

Hence if a Paper be applied to a convex Lens (especially in a dark Room) at the Distance of its Focus, the Images of Objects shining upon it will be represented distinctly, and in their natural Colours thereon: Nor is the Focus of the Sun's Rays any thing else, in effect, but the Image of the Sun. Hence in Solar Eclipses the Sun's Image, eclipsed as it is, may be burned by a large Lens on a Board, &c. a very entertaining Phænomenon.

Hence also, if a convex Lens of any kind be exposed both to nearer and remoter Objects, and a Paper at the same time be applied, so as to receive the Images of Objects distinctly, the Distance of the Focus from the Lens, and thence the Diameter of the Convexity, may be determined.

If a concave Mirror be so placed, as that an inverted Image form'd by Refraction thro' a Lens be found between the Centre and the Focus, or even beyond the Centre, it will again be inverted by Reflection, and so appear erect in the first Case beyond the Centre, and in the latter between the Centre and the Focus. On these Principles is built the *Camera obscura*.

The Diameter of the Image of an Object delineated beyond a convex Lens, is to the Object itself in a Ratio of the Distance of the Image, to that of the Object.

Since then the Image of a remoter Object is less distant from the Lens than that of the nearer, the Image of the more remote will be less than that of the nearer. And because the Distance of the Image from the Lens is greater, if the Lens be a Segment of a greater Sphere, than of a less, hence the Image will be greater in the former Case than in the latter. The Image therefore will be of such a Magnitude, as it would be of were the Object to shine into a dark Room thro' a little Hole upon a Wall, at the same Distance from the Hole, at which the Focus is from the Lens. When an Object is less distant from a Lens than the Focus of parallel Rays, the Distance of the Image is greater than that of the Object; otherwise the Distance of the Image is less than that of the Object: In the former Case, therefore, the Image is greater than the Object, in the latter less.

If the Images be made greater than the Objects, they will not appear distinctly; because in that Case there are fewer Rays which meet after Refraction

in the same Point: Whence it happens that Rays proceeding from different Points of an Object, terminate in the same Point of an Image, which is the Cause of Confusion. Hence it appears, that the same Aperture of a Lens mayn't be admitted in every Case, if we would keep off the Rays which produce Confusion. However, tho' the Image is then most distinct, when no Rays are admitted but those near the Axis, yet for want of Rays the Image is apt to be dim.

If the Eye be placed in the Focus of a convex Lens, an Object view'd thro' it appears erect and enlarg'd, in a Ratio of the Distance of the Object from the Eye, to that of the Eye from the Lens, if it be near; but infinitely, if remote.

For Concave Lens's, their Laws are as follow:

If parallel Rays strike on a plano-concave Lens  $KL$ , (Plate 3. Fig. 27.) and  $FC$  be to  $FB$  in the Ratio of the Refraction, the Rays will diverge from the Axis, and the Point of Divergency or Dispersion, call'd the *Virtual Focus*, will be  $F$ .

For the Ray  $HI$ , parallel to the Axis, is perpendicular to  $KL$ , and will therefore pass unrefracted to  $E$ . Wherefore  $FC$  being to  $FB$  in the Ratio of Refraction,  $F$  will be the virtual Focus.

If then the Lens be Glass,  $FB = 2 BC$ ; i. e. the virtual Focus  $F$  will be distant from the Lens  $KL$  a Diameter and an half  $3 BC$ .

If the Ray  $AE$ , (Plate 3. Fig. 28.) on a Lens parallel to the Axis  $FP$ , strike on a Lens concave on both sides; and both  $FC$  be to  $FB$ , and  $IP$  to  $PH$  in the Ratio of Refraction; and  $FP : PH :: FB : BG$ ;  $G$  will be the Point of Dispersion, or the virtual Focus.

If therefore the Refraction be in a Glass Lens, the Sums of the Semi-diameters  $CB$  and  $HI$ , will be to the Diameter of the Concavity of either  $2 HI$ , as the Semi-diameter of the other  $CB$  to the Distance of the virtual Focus from the Lens  $BG$ .

Hence the Sun's Rays striking on a concave Lens; their Light after Refraction will be considerably weaken'd; so that the Effect of concave Lens's is opposite to that of convex ones.

Lastly, an Object view'd thro' a concave Lens appears erect, and diminished in a Ratio compounded of the Ratio's of the Space in the Axis, between the Point of Incidence and the Point to which an oblique Ray would pass without Refraction, to the Space of the Axis between the Eye and the Middle of the Object; and the Space in the same Axis between the Eye and the Point of Incidence, to the Space between the Middle of the Object and the Point the oblique Ray would pass to without Refraction.

Tho' the Properties of Lens's have been here considered principally with regard to Rays falling near the Axis, and parallel thereto; yet the Reasoning will be easily transferr'd to Rays remoter from the Axis, and falling in any Direction. Thus we may say universally, that in a convex Lens all parallel Rays become converging, and concur in a Focus; that diverging Rays either become less diverging, or run parallel, or converge; and that converging Rays converge the more; All which Alterations are more sensible in oblique Rays than in perpendicular ones, by reason the Angles of Incidence in that Case are greater.

In concave Lens's all parallel Rays become diverging; diverging Rays diverge more; converging Rays either converge less, or become parallel, or go out diverging: All which things hold of oblique as well as direct Rays, but more sensibly in the first.



A Lens, one of whose Surfaces is convex, and the other concave, is called a *Meniscus*.

Some confine Lens's within the Diameter of five or six Lines, and will have such as exceed that Diameter call'd *Lenticular Glasses*. Lens's are distinguished with regard to their Preparation, into *ground* and *blown*. Blown Lens's are little Globules of Glass melted in the Flame of a Lamp or Taper; but the Figure of these is seldom exact; besides that the Smoak of the Lamp cleaves to the Surface in melting: On both which accounts they come short of the Clearness of those that are ground, or turned and polish'd in the Turn-tool, as was done by the famous *S. Campani*: But the best way of preparing Lens's is by grinding, as practis'd by our famous Mr. *Scarlet*, Optician to his Majesty.

LENTA *Febris*, the slow or lingering Fever, is usually reckoned among the *Symptomatical*, and proceeds from some hidden Putrefaction sticking to some Bowel, so that its Substance is almost corrupted. Such a kind of Fever is often bred in the Consumption of the Lungs, and degenerates into an *Hætick*. *Blanchard*.

LENTIFORM Prominences: see *Corpora Striata*.

LENTIGINES, are what we call *Freckles*.

LEO, is the Fifth of the Twelve Signs of the *Zodiac*.

LEONTINE [in *Poetry*], a Sort of Verses which rhyme at every Hemistich, the Middle always chiming to the End.

LEPIDOIDES [of *λεπίς* a Scale, and *ἔδος* Form], is the scaly Suture of the Skull: see also *Mendosa*.

LEPRA *Arabum*, the same with *Elephantiasis Græcorum*.

LEPROSO *Amovendo*, is a Writ that lies for a Parish, to remove a Leper or Lazar, that thrusteth himself into the Company of his Neighbours, either in Church or in other publick Meetings, to their Annoyance or Disturbance.

LEPROSY, is a dry Scab, whereby the Skin becomes scaly like Fish: It differs from *Leuce* and *Alphus*, in that a *Leprosy* is rough to the Touch, and causes an Itching; for the Skin is the only Part affected, and therefore that being flead off, the Flesh underneath appears sound and well.

LEPTUNTICA, are attenuating cutting Medicines, which part or cut the gross and viscous Humours with their acute Particles.

LEPUS, the *Hare*, a Southern Constellation, containing 13 Stars.

LESSER *Circles of the Sphere*, are those whose Planes do not pass thro' the Center of the Sphere; and which do not divide the Globe into two equal Parts, but are parallel to *Greater Circles*: As the Tropicks and Polar Circles, and all Parallels of Declination and Altitude; which latter being parallel to the Horizon, are called *Almacanters*.

LESSOR and *Lessee*, are Terms of the Common Law: The *Lessor* is he that leaseth out Lands or Tenements to another for Term of Life, for Years, or at Will: And the Person to whom such a Lease is made, is called the *Lessee*.

LETHARGUS, a *Lethargy*, is a Disease causing an heavy Sleep, like that Distemper called *Coma*, but accompanied with a Fever and a *Delirium*; and is supposed to be an Heap of too much or incongruous moist Matter within the Pores of the Cortical Substance of the Brain. This Distemper does not seem to come of itself, but rather from the Demigration of Fevers.

LETHE } a Measure or Portion of Land, be-  
LATHE } ing one of the antient Divisions in  
*England*; it comprehended three or four Hundreds. The Hundred was a Division wherein there were a hundred Officers to secure the Peace; also the Jurisdiction of a Viscount, or a kind of Assize, held once a Year about *Michaelmas* in each Village.

LETTERS *Patent*, are Writings sealed with the Great Seal of *England*, whereby a Man is authorized to do or enjoy any thing that otherwise of himself he could not. And they are so termed of their Form, because they be open, with the Seal affixed, ready to be shewed for Confirmation of the Authority given by them. Common Persons may grant *Letters Patents*; but they are rather call'd *Patents*, than *Letters Patents*, to make *Denizens*; yet for Difference sake, those granted by the King are called *Letters Patent Royal*.

LETTER of *Attorney*, is a Writing authorizing an *Attorney*; that is, a Man appropriated to do a lawful Act in our stead: As a *Letter of Attorney* to give Seisin of Lands, to receive Debts, to sue a third Person, &c.

LETTERS of *Respite*, Letters issued out by a Prince in favour of honest unfortunate Debtors, against too rigorous Creditors, for the Delay of Payment for acertain time.

LET *Fall*, the Word at Sea for putting out a Sail when the Yards are aloft, and the Sail is to come down from the Yard; but when the Yards are stricken down, then the Sail is loosed below, before they hoise the Yard. Neither is it properly said of *Top-sails*, because they lie on the top; and therefore the Word for them is, *Heave out your Top-sails*. Nor can it be applied to the *Mizzen*; for to it the Word is, *Strike the Mizzen, and set it*: So that in Strictness it belongs only to the *Main-sail*, *Fore-sail*, and *Sprit-sail*, when their Yards are hoisted up aloft.

LEVANT, in Geography, is properly the Eastern Side of any Continent or Country, or that on which the Sun rises. But now with our Seamen it signifies the Mediterranean Sea, and especially the Eastern Part of it; and our Trade thither is called the *Levant Trade*; and a Wind that blows from thence out of the *Streights Mouth* is called a *Levant Wind*.

LEVANT and *Couchant*, is when Cattle have been so long in another Man's Ground, that they have lain down, and are risen again to feed.

LEVARI *Facias*, is a Writ directed to the Sheriff, for levying of a Sum of Money upon Lands and Tenements of him that hath forfeited a Recognizance.

LEVARI *facias damna de disseisitoribus*, is a Writ directed to the Sheriff, for the levying of Damages, wherein the *Disseisor* hath formerly been condemn'd to the *Disseisee*.

LEVARI *facias residuum debiti*, is a Writ directed to the Sheriff, for the levying the Remnant of a Debt upon Lands and Tenements or Chattels of the Debtor that hath in part satisfied before.

LEVARI *facias, quando vicecomes returnavit quod non habuit emptores*, is a Writ commanding the Sheriff to sell the Goods of the Debtor which he hath already taken, and returned that he could not sell them, and as much more of the Debtor's Goods as will satisfy the whole Debt.

LEVATORES *Ani*, are Muscles which arise fleshy from each side of the *Ossa Pubis*, internally within the *Pelvis*, as also from part of the *Os Ischium* and *Sacrum*. From these Places, like Lines



drawn from a Circumference towards a Centre, its Fibres descend over the *Musculi Marfupiales* to their Implantation at the lower end of the *Intestinum Rectum* in the *Anus*. The Use of these Muscles is chiefly to suspend and draw the *Anus* upwards, lest the *Fæces* should be burthensome to the *Sphincter*.

LEVATOR *Scapulæ*, is a Muscle of the Shoulder-Blade, by some called *Levator Patientiæ*, because we make use of it in large Inspirations, in order to expire; as when we sigh (as they call it). This lies immediately under the *Cucullaris*, arising by so many separate Originations from the second, third, fourth, and fifth transverse Processes of the *Vertebræ* of the Neck; which uniting into one large fleshy Body, descends obliquely to its Insertion at the superior Angle of the *Scapulæ*: Its Name declares its Office.

LEUCE, [*λευκή*, Gr.] is a cutaneous Disease, when the Hairs, Skin, and sometimes the Flesh underneath, turns white; the Flesh being pricked with a Needle, is not sensible, nor emits Blood, but a milky Humour. It differs from *Alphus*, in that it penetrates deeper, and changes the Skin, so that the Hairs are changed too.

LEUCOMA, [*λευκωμα*, Gr.] is a white Scar in the horny Tunick of the Eye; the same with *Albugo*.

LEUCOPHLEGMATIA [*λευκωφλεγματία*, of *λευκόν* white, and *φλέγμα*, Gr. *Phlegm*] is a pituitous Dropsy, or a Dropsy that seizes the whole Body; which in the Beginning is called *Cachexia*, and differs from it only in Degree.

LEVEL of Carpenters, is an Instrument made of a long Piece of Wood at bottom, and with an upright one to hold a Thread and Plummets, which plays about a perpendicular Line there drawn; and when it falls exactly on it, then is the bottom piece in a true Level, or horizontal Position.

LEVEL, is an Instrument made of Wood or Brass, with two Sights and a Glass, almost filled with coloured Spirit of Wine, but so as to leave room for a Bubble of Air to play up and down in it: It hath a Cover, divided into several equal Parts, whereby to adjust the Bubble; with a Spring to fit it to the three-legg'd Staff, and a long Screw, to rectify the Bubble by the Help of a Plummets that hangs on one of the Sights. Sometimes, instead of the long Screw and Spring, there is fitted a Rack, being two Semi-circles at Right Angles, with a Thread or Worm upon two endless Screws; which, with a Key, readily brings the Instrument to a true Level; and sometimes to help the Sight, there is added a *Telescope*. There also belongs to this Instrument two or more *Station-Staves*; and it is used by *Engineers*, *Surveyors*, &c. to find the true Level for conveying Water to supply Towns, making Rivers navigable, draining Bogs, &c.

LEVEL. In *Phil. Transact.* N. 141. there is an Account of a new Level by Mr. *Butterfield*, which he saith is done by a Tube with Glasses, and a Thread hanging between four Points, with a Weight in a Box; so contrived, that as soon as the Instrument is set down, you have the Point of Horizon with a great deal of Exactness; and he said he was then making another which play'd on the Point of a Diamond. But I have never heard any thing of this since, and Mr. *Butterfield*, Instrument-Maker to the French King, is now dead.

In *Phil. Transf.* N. 74. p. 2217, is an Account of a Book, then publishing, about the *Art of Levelling*, by Mr. *Mariotte*; but whether it was ever actually published, I know not. Capt. *Halley*, Geometry Professor at Oxford, from his Observations

of the Height of the Mercury in the Barometer, at the Top and Bottom of *Snowdon-Hill* in *Wales*, (where at the Top it sunk three Inches eight Tenths lower than its Height at the Foot of the Hill) concludes, that one of our new portable Barometers would be accurate enough to take the Levels for bringing Water from distant Places, and would be much less subject to Error than the common Levels, there being  $\frac{1}{10}$  of an Inch for every 30 Yards; which may be divided into many Parts evidently. See *Phil. Transact.* N. 229. And Mr. *Derham*, by Observations of this nature made at the Foot and Top of the Monument, allows  $\frac{1}{10}$  of an Inch to 82 Foot of perpendicular Ascent, when the Mercury standeth at 30 Inches.

There is a Book written on the Subject of Levelling by Mr. *De la Hire*, but I have not seen it. And there is a Description of a new levelling Instrument by Mr. *Couplet*, in the *French Memoirs* for 1699.

LEVELLING, is the Art of finding a true horizontal Line, or the Difference of Ascent or Descent between any two Places, in order to drain Moors, Marshes, and Morasses, &c. or to convey Water from Place to Place. The Instruments made use of you will find under the Word *Level* and *Pendulous Level*.

The Method of proceeding in the Art of Levelling is, or may be much the same, let the Instrument be the common *Water-Level*, that of *Spirit of Wine*, or the new *pendulous one*. The most commodious and expeditious Way is to provide two Station-Staves of square Deal, like Rulers, about 8 or 10 Foot in Length. Let every Foot be divided into 10 Parts, and each of those into 10 more; so each small Division will be the 100th Part of a Foot. On each of these Staves there must be a Vane to slide up and down, and with a Screw in the back Part to fasten it to any Height on the Staff. The Fore-side of the Vane or Sight should be painted white, or covered with white Paper, with a black Line drawn across it lengthways. Having then two Assistants to hold these Staves upright, and to slide the Sights up and down, supposing you were to find the Difference of the Heights of any two Places, as of *A* and *B*, *Fig. 1.* if one Station will do, place the Level in the middle between the Places, and having by the Bubble or otherwise set it truly horizontal, look back to the first Place, till your Assistant sliding the Vane up and down for you there on the Staff, you can see the black Line thereon cut or cover'd by the cross Hair in the Telescope; and then let him mark the Height of that black Line above the Ground on the Divisions on the Staff. Then turn the Telescope about, and look towards your other Assistant at *B*, till you can see the black Line on the Vane or Sight on his Staff co-inciding with the cross Hair in the Telescope; and let him also note how high his black Line is above the Ground: If his Number be the same with the former, the Places are on a level, or of the same Height; otherwise that where the greatest Number is, is the highest; and the Difference between the Numbers shews how much.

But if the Places are so far asunder, or have Obstacles interposing, that you can't do it at one Station, as is usually the Case, then you must do it at as few more than one as you can; and you must keep an Account of the Numbers on the Staves at all your Stations, putting the back Station in one Column, and the fore Station in another, with a Column for the Number of their Stations in the Middle; in this, or such like Form.



Backd	St	Forwd.
0.29	1	1.32
1.78	2	2.01
1.99	3	2.95
2.21	4	2.56
6.27		8.84
		6.27
		2.57

Where all the Back Stations make together 6.27 . or six Foot and .27 of a Foot, and all the Fore Stations make 8.84 . or 8 Feet and .84 of a Foot; and the Difference between those two Numbers being 2.57 . or 2 Feet .57 of a Foot, is the Excess in Height of the last place above the first.

N. B. In levelling of Rivers, you must set the Black Line of the Sight in the first Backward, and in their last Fore Station, just to the Edge of the Water: And then you may take the Intermediate Stations, any where, a Mile off from the River, &c. in the Meadow adjoining, for it will all come right at last.

### How to rectify Levels.

To rectify Levels, as for Example, *Fig. 2.* the Air Level, you must plant two Staffs, as *A, B*, about 50 Toises distant from each other, because of the Roundness of the Earth; (take care of exceeding that Distance) then eyspying from the Station *A*, the Point *B*, the Level being placed horizontally, and the Bubble of Air being in the middle of the Tube, you must raise or lower a Piece of Pastboard upon the Staff *B*; in the middle of which is drawn a black horizontal Line, till the visual Ray of the Observer's Eye meets the said Line; after which must be fastened any other Piece of Pastboard to the Staff *A*; the middle of which let be the Height of the Eye, when the Piece of Pastboard *B* was seen: then removing the Level to the Staff *B*, place it to the Height of the Center of the Pastboard; and the Level being horizontally posited for observing the Piece of Pastboard *A*, if then the visual Ray cuts the middle of the Piece of Pastboard, it is a Sign the Level is very just; but if the visual Ray falls above or below, as in the Point *C*, you must, by always keeping the Eye at the same Height, lower the Telescope or the Sight, till the middle of the visual Ray falls upon the middle of the Difference, as in *D*; and the Telescope thus remaining, the Tube of the Level must be adjusted till the Bubble of Air fixes in the middle; which may be done by means of the Screw 4.

Again; return to the Staff *A*, and place the Level the Height of the Point *D*, for looking at the Piece of Pastboard *B*; and if the visual Ray falls upon the middle of the Piece of Pastboard, it is a Sign the Telescope agrees with the Level; if not, the same Operations must be repeated until the visual Rays fall upon the Centers of the two Pieces of Pastboard.

### Of the Uses of the aforesaid Instruments.

Levelling is an Operation showing the Height of one Place in respect to another. One Place is said to be higher than another, when it is more distant from the Center of the Earth. A Line equally distant from the Center of the Earth in all its Points, is called the Line of true Level; whence, because the Earth is round, that Line must be a Curve, and make a part of the Earth's Circumference, as the Line *C B F*; all the Points of which are equally distant from the Center *A* of the Earth: But the Line of Sight, which the Operations of Levels give, is a right Line perpendicular to the

Semidiameter of the Earth *AB*, raised above the true Level, denoted by the Curvature of the Earth, in proportion as it is more extended: For which Reason, the Operations which we shall give, are but of the apparent Level, which must be corrected to have the true Level, when the Line of Sight exceeds 50 Toises.

The following Table, in which are denoted the Corrections of the Points of apparent Level, for reducing them to the true Level, was calculated by help of the same Diameter of the Earth, whose Length may be known by measuring one Degree of its Circumference. The Gentlemen of the Academy of Sciences, have found by very exact Observations, that one Degree of the Circumference of a great Circle of the Earth, as the Meridian, contains 57060 Toises; and giving 25 Leagues to a Degree, a League will be  $228\frac{2}{3}$  Toises.

Now the whole Circumference of the Earth will be 9000 of the same Leagues, and its Diameter 2865 of them; from whence all Places on the Surfaces of the Earth, will be distant from its Center  $1432\frac{1}{2}$  Leagues.

The Line *AB*, *Fig. 3.* represents the Semidiameter of the Earth, under the Feet of the Observer. The Right Line *BDE*, represents the visual Ray, whose Points *D* and *E* are in the apparent Level of the Point *B*. This Line of apparent Level serves for determining a Line of true Level, which is done by taking from the Points of the Line of apparent Level, the Height they are above the true Level, in respect to a certain Point, as *B*; for it plainly appears from the Figure, that all the Points *DE* of the apparent Level, are farther distant from the Center of the Earth than the Point *B*; and to find the Difference, you need but consider the Right-angled Triangle *ABD*, whose two Sides *AB, BD*, being known, the Hypothenuse *AD* may be found: From which subtracting the Radius *AC*, the Remainder *CD* will show the Height of the Point *D* of apparent Level above the Point of true Level.

A TABLE shewing the Corrections of the Points of Apparent Level, for reducing them to the true Level every 50 Toises.

Distances of the Points of apparent Level.	Corrections.	
	Inches.	Lines.
50 Toises	0.	0
100	0.	$1\frac{1}{3}$
150	0.	3
200	0.	$5\frac{1}{3}$
250	0.	$8\frac{1}{3}$
300	1.	0
350	1.	$4\frac{1}{3}$
400	1.	$9\frac{1}{3}$
450	2.	3
500	2.	9
550	3.	6
600	4.	0
650	4.	8
700	5.	4
750	6.	3
800	7.	1
850	7.	$11\frac{1}{3}$
900	8.	11
1950	10.	0
000	11.	0

The Rule serving to calculate this Table, is to divide the Square of the Distance by the Diameter of the Earth, which is 6,538,694 Toises; for which Reason



Reason the Corrections are to one another, as the Squares of the Distances. Although the Foundation of this Calculation be not strictly geometrical, yet it is nigh enough the Truth of Practice.

If the Points of apparent Level should be taken instead of the Points of true Level, a Body would err in conducting the Water of a Source; which let be, for Example, at the Point  $B$ ; for this Source will not run along the Line  $BDE$ , but will remain in the Point  $B$ ; for if it should run along the Point  $BE$ , it would run higher than it is, which is impossible, because it cannot be endued with any other Figure but a circular one, equally distant from the Center of the Earth. On the contrary, a Source in  $D$  will have a great Descent down to the Point  $B$ ; but it cannot run farther, because it must be elevated higher than the Source, if it continues its way in the same Right Line; which cannot be done, except it be forced by some Machine.

LEVER, is a kind of Ballance or Rod, as  $AB$ , Fig. 1. which instead of being suspended from, rests upon a Point as  $C$ , which we have called the fix'd Point or Center of Motion, having the Weight on one Side, and the Power on the other. It has been so call'd, because it serves to bear and raise Burdens with Facility; and so much the more easily as the Power is more distant from, or the Weight nearer to the fix'd Point, as we shall demonstrate after we have described two or three sorts of Levers of common use.

The Lever of the first Kind, is that wherein the Prop, or the fix'd Point  $C$ , Fig. 1. is between the Weight suspended at the End  $A$ , and the Power applied at the other End  $B$ ; it is plain that Scissors, Pinchers, Snuffers, &c. are Levers of the first Kind.

The Lever of the second Kind is that wherein the fix'd Point  $C$ , Fig. 2. is at one End, and the Power applied at the other End  $B$ , the Weight  $D$  being suspended at the Point  $A$  between the Ends; that is, between the Power and the fix'd Point: it is plain that the Oars and Rudder of a Boat are Levers of the second Kind; as also Cutting Knives as are fix'd at one End, as those us'd by Druggists for cutting aromack Wood and Roots, by Bakers for cutting their Bread, and Last-makers for cutting Wood; and likewise Doors, whose Hinges are as the fixed Point.

The Lever of the third Kind, is that whose fix'd Point  $C$ , Fig. 3. is at one End, and the Weight  $D$  suspended at  $A$  the other End, the Power being applied at the Point  $B$  between the Ends; that is, between the Weight and the Fulcrum: it is plain that a Ladder which is lifted by the middle, in order to rear it against a Wall, is a Lever of the third Kind.

There is yet a fourth Kind of Lever, call'd the Bended Lever, whose Use will be shew'd in the Sequel, as  $ACB$  (Fig. 4.) so call'd from its being bent at the fix'd Point  $C$ ; it appears plainly that such a Lever is of the first Kind, because the Weight  $D$  hangs at its End  $A$ , and the Power is applied at its other End  $B$ , where it draws by the Line of Direction  $BE$ : a Hammer to draw out a Nail, is a Bended Lever.

### THEOREM.

*As much as the Power gains in Force, as it moves a Body with a Lever, so much it loseth in Time and Space.*

Suppose the Lever  $AB$  (Fig. 5.) whose fix'd Point is at  $C$ , to have a Weight fix'd to it, whose Center of Gravity corresponds to the End  $A$ , and a Power at the other End  $B$ ; this Power in moving the Weight, will give the Position  $DE$  to the Lever  $AB$ ; in which Case the Weight will describe the Arch  $AD$ , and the Power the Arch  $BE$  about the Fulcrum  $C$ . If the Power at  $B$  only sustain'd the Weight at  $A$ , it would have the same Ratio to the Weight, as  $AC$  the Distance of the Weight has to  $BC$  the Distance of the Power; but as we suppose that it is able to move it, it must of consequence have a greater Ratio to the Weight, than the Space  $AD$  has to the Space  $BE$ ; so that if the Power be a great deal less than the Weight, so must  $AC$ , the Distance of the Weight, be reciprocally a great deal less than  $BC$  that of the Power, and consequently the Space  $AD$ , which the Weight goes through; because the Arches  $AD$ ,  $BE$ , which measure the equal Angles  $ACD$ ,  $BCE$  are similar, and consequently as their Radii  $AC$ ,  $BC$ .

Whence we may easily conclude, that the Power runs thro' a greater Space than the Weight, proportionably as it is less than the Weight, because the less the Power is, the greater must its Distance  $BC$  be to enable it to move the Weight, which must after the same manner increase the Space  $BE$  which it runs thro': so that if the Distance  $BC$  is, for Example, ten times greater than the Distance  $AC$ ; likewise the Space  $BE$  of the Power, will be ten times greater than the Space  $AD$  of the Weight; because, as we have already said, the two Arches  $AD$ ,  $BE$  being similar, are to one another as their Radii  $AC$ ,  $BC$ . Whence it follows, that the Power will be ten times as long in moving the Weight, by means of the Lever  $AB$ , as it would be in moving it without a Lever.

Thus you see, that if on the one hand your Force be increas'd by applying the Power farther from the fix'd Point, on the other hand you lose something of the Space, or of the Time: so that if you can raise a Body of 100 Pound Weight with the Lever  $AB$ , the Power being at  $B$ , and the Weight at  $A$ , you may likewise raise 200 Pound Weight applied at  $A$ , if you double  $BC$  the Distance of the Power; but if you take off thus half the Gravity of the Weight, you must employ as much more Time in the Operation, because in this Supposition the Power must run thro' a greater Space.

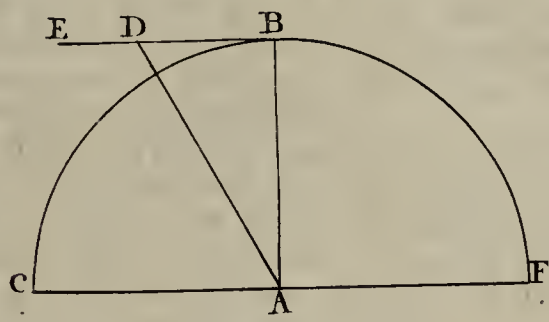
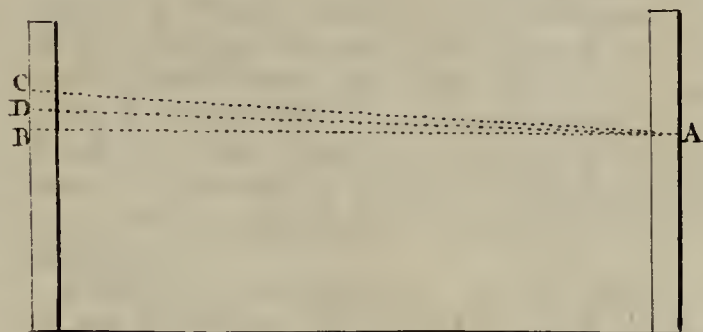
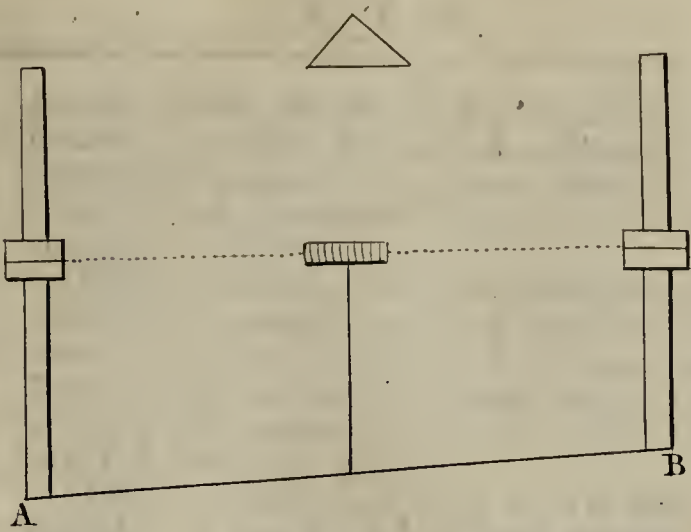
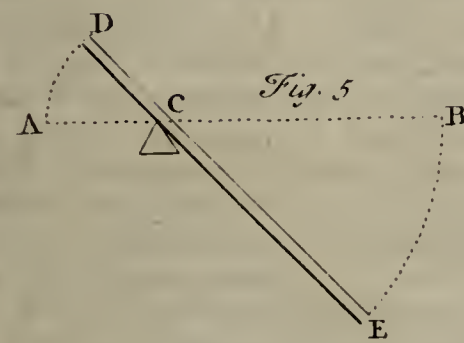
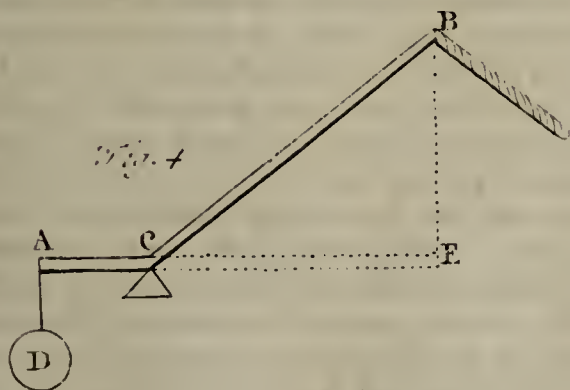
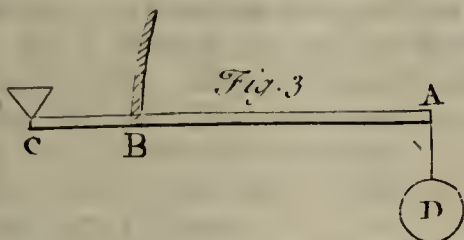
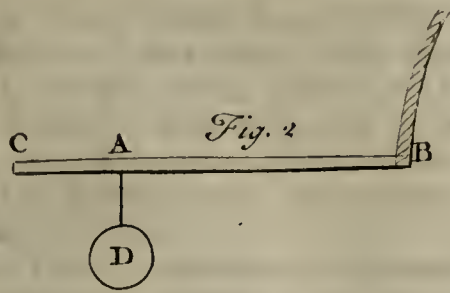
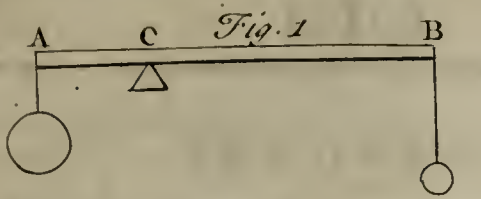
Hence it is plain, that the farther the Power moves, the greater is its Force, which happens not only in the Lever, but also in all the other Engines, as you will see in the Sequel. And it is by this Principle of Velocity and Space, that *Galileus* and *Cartesius* have explained the Effect of Mechanical Engines; and tho' this Principle does not satisfy the Mind enough to serve for a Demonstration, yet we have no Reason to doubt of it, after what we have said hitherto, and what we shall say concerning the other Engines.

### SCHOLIUM.

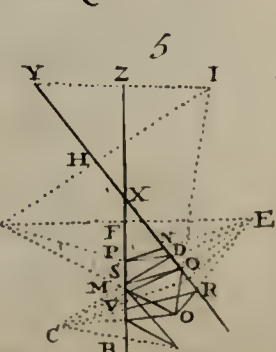
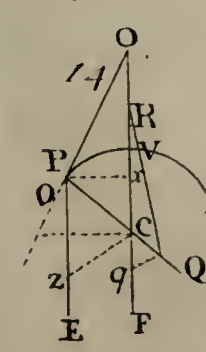
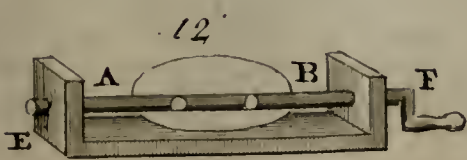
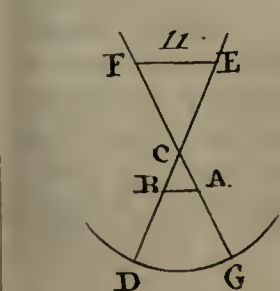
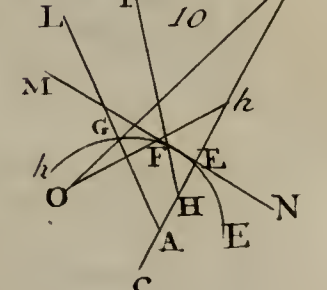
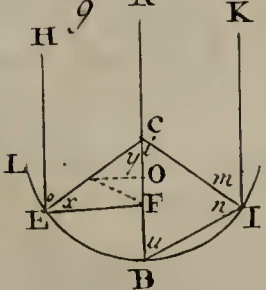
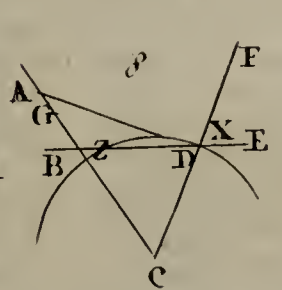
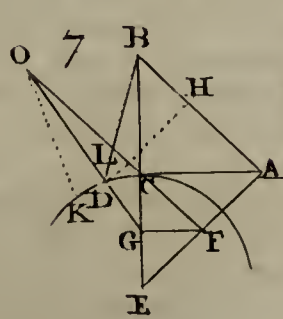
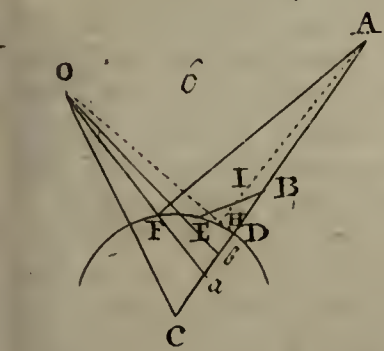
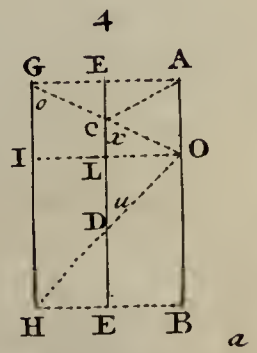
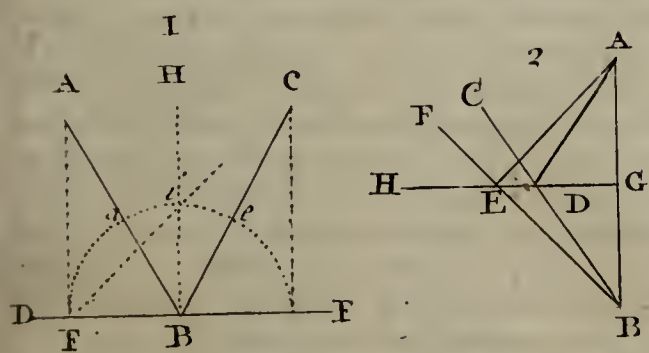
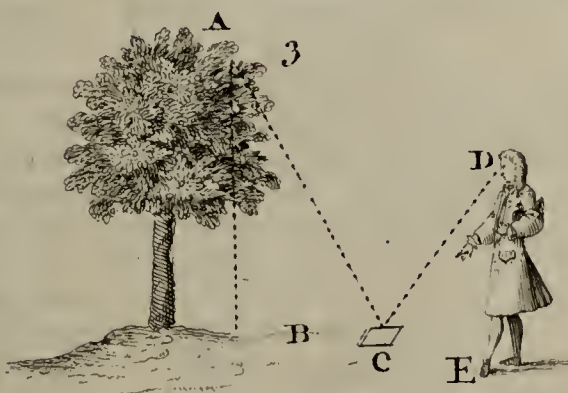
Because the Lever passes thro' the Center of Gravity of the Weight, it is evident that the Force of the Power will be alike in all Positions; that is, that the Power will weigh no more upon the horizontal Lever  $AB$ , than upon the inclin'd one  $DE$ ; but this will not hold when the Lever does not pass thro' the Center of Gravity of the Weight, as you will see in the following Theorem.



# Lever



# Mirrou









THEOREM.

If a Power whose Line of Direction is perpendicular to a Lever, bears up by means of that Lever a Weight, whose Center of Gravity is above the Lever, it must be greater to bear it up when the Lever is horizontal, than when it is inclin'd, and the Weight rais'd; and greater yet, when the Weight is lower.

LEVER, is the second *Mechanical Power*; and so considered, is only a *Balance* supported by a *Hypomochlion*; only the Center is not in the Middle, as it is in the common *Balance*, but near one End; for which Reason 'tis used to elevate or raise a great Weight; whence comes the Name *Lever*.

LEVIGATION, in Chymistry, is the *grinding* any hard Matter to a very fine, or as they say, an impalpable Powder upon a Marble, as the Painters grind their Colours.

LEVITATION, is a Word I have met with nowhere but in Dr. Hook's *Opera Posthuma*; and he means by it a Property directly contrary to that of Gravitation towards the Sun: And in his Discourse of Comets, p. 168, he saith he hath by many Observations discovered, that tho' there be a Descent of the Steams from the *Nucleus* of the Comet towards the Sun, yet they also quickly returned and went contrary and opposite to the Sun, and that sometimes to a prodigious Extent. And perhaps where the Power or Force of Gravitation ceases, some such *contrary Force* may begin: Of which there seem to be many Instances in the Gravitations or Attractions of the Particles of Matter toward one another. (See *Attraction*.) This Force in such Cases Sir Isaac Newton calls *Vis Repellens*; and it appears plainly to be one of the Laws of Nature, or a Branch of the Will of our Creator in the material World; and without it I think there can be no possible Account of Rarefaction, and some other *Phænomena* of Nature. Dr. Hook, p. 170, takes notice also, that there is as *vast an Acceleration* in the Motion of *Levitating Bodies*, as there is in *Gravitating* ones.

LEVITY, is the Diminution or Want of Weight in any Body, when compared with another that is heavier; and in this Sense is opposed to *Gravity*. The Schools maintain there is no such thing as *Positive* or *Absolute Levity*; and this they would have to be the Cause of the Emergency of Bodies lighter in Specie than Water, up to the Surface of that Liquor. But besides that, the common Sense of Mankind discovers *Gravity* and *Levity* to be only relative and comparative Things. The honourable Mr. Boyle hath by many Experiments shewn, That the rising of Bodies from the Bottom to the Surface of Water, if lighter specifically than it, is by no means solvable nor accountable by any such Notion as that of *Positive Levity*, but exactly agreeable to the Laws of the *Hydrostaticks*: See his *New Experiments about the Positive or Relative Levity of Bodies*, and *Hydrost. Paradoxes*.

LIBEL, signifies the Original Declaration of any Action in the Civil Law; as also a criminous Report of any Man cast abroad, or otherwise unlawfully publish'd, and then called *Famofus Libellus*; and this is either *In Scriptis*, or *Sine Scriptis*. *In Scriptis*, is when an *Epigram*, or other Writing, is composed or publish'd to another's Disgrace, which may be done *Verbis aut Cantilenis*; as where this is maliciously repeated or sung in the Presence of others; or else *Traditione*, when the *Libel*, or any Copy of it, is delivered out to scandalize the Party.

*Famofus Libellus sine Scriptis*, may be twofold: 1. *Picturis*, as to paint the Party in a shameful and ignominious manner: Or, 2. *Signis*, as to fix a Gallows, or other ignominious Signs, at the Door of the Party, or elsewhere.

LIBELLO *habendo*: See *Copia Libelli deliberanda*.

LIBERA, anciently signified a *Livery* or Delivery of so much Grass or Corn to a customary Tenant, who cuts down or prepares the said Grass or Corn, and receives some Part or small Portion of it as a Reward or Gratuity.

LIBERA *Chasea habenda*, is a Writ Judicial, granted to a Man for a free Chase belonging to his Manor, after he hath by a Jury proved it to belong to him.

LIBERTATE, is a Writ issuing out of the Chancery to the Treasurer, Chamberlains, or Barons of the *Exchequer*, or Clerks of the *Hamper*, &c. for the Payment of any annual Pension or other Sums granted under the Great Seal: Or sometimes to the Sheriff, &c. for the Delivery of any Lands or Goods taken upon Forfeits of Recognizance. It lies also to a Gaoler, for the Delivery of a Prisoner that hath put in Bail for his Appearance.

LIBERTAS *Ecclesiastica*, was the usual Phrase in our old Writings to express Church Liberty and Ecclesiastical Immunities. At first this was only the *Right of Investiture*; but afterwards it grew very great, extending so far under some weak Governments, as to a Pretence of Exemption of the Persons and Possessions of the Clergy from the Civil Power and Jurisdiction.

LIBERTATIBUS *Allocandis*, is a Writ that lies for a Citizen or Burgess of any City or Borough, that contrary to the *Liberties* of the City or Town whereof he is, is impleaded before the King's Justices, or Justices Errant, or Justice of the Forest; &c. to have his Privilege allowed.

LIBERTATIBUS *Exigendis in Itinere*, is a Writ whereby the King willeth the Justices in Eyre to admit of an Attorney for the Defence of another Man's *Liberty* before them.

LIBERTINE, in the Civil Law, is a Person who is manumised and made free from Bondage, to which he was born.

LIBERTY, is the Power a Man hath to do, or forbear doing, any particular Action, according as its Doing or Forbearance has the actual Preference in the Mind; which is the same thing as to say, according as he himself *wills* it.

LIBRA, one of the twelve Signs of the *Zodiack*, being exactly opposite to *Aries*.

LIBRA. See *Pound*.

LIBRA, a Mechanick Power. See *Balance*.

LIBRA PENSA [in antient Law Books] a Pound of Money in Weight; it being usual in antient Times not only to tell Money, but to weigh it; because many Cities, Lords, and Bishops were allowed to have Mints and to coin Money, which was frequently bad.

LIBRATA *Terra*, was antiently a Quantity of Land containing 4 Ox-gangs, and every Ox-gang 15 Acres.

LIBRATION of the Earth [*Astronomy*] is that Motion of the Earth so retain'd in its Orbit, as that its Axis continues continually parallel to the Axis of the World.

LIBRATION of the Moon, (see *Evection*) is of three Kinds:

1. Her *Libration in Longitude*; which is a Motion arising from the Plane of that Meridian of the Moon, (which is always, nearly, turned towards us)



being directed not to the Earth, but towards the other Focus of the Moon's Elliptical Orbit; and so to an Eye on the Earth she seems to librate to and again in Longitude, or according to the Order of the Signs in the Zodiack. This *Libration* is of no Quantity twice in each periodical Month; viz. when the Moon is in her Apogee, and in her Perigee; for the Plane of her Meridian above-mentioned, is directed alike to both the Foci.

2. Her *Libration in Latitude*; which arises hence, That her Axis not being perpendicular to the Plane of her Orbit, but inclined to it, sometimes one of her Poles, and sometimes the other, will *nod* (as they call it) or dip a little towards the Earth; (as is the Case of the Poles of the Earth towards the Sun) and consequently she will appear to librate a little, and to shew sometimes more of her Spots, and sometimes less of them, towards each Pole: Which *Libration* depending on the Position of the Moon, in respect of the Nodes of her Orbit with the Ecliptick, (and her Axis being perpendicular nearly to the Plane of the Ecliptick) is very properly said to be in *Latitude*.

And this is compleated in the Space of the Moon's *Periodical Months*; or rather while the Moon is returning again to the same Position, in respect of her Nodes.

3. There is also a *Third kind of Libration*, by which it happens, that though another Part of her is not really obverted to the Earth, as in the former *Librations*, yet another is illuminated by the Sun: For since her Axis is perpendicular nearly to the Plane of the Ecliptick, when the Moon is most Southerly, in respect of the Ecliptick *North Pole*; some Parts nearly adjacent to it will be illuminated by the Sun; while, on the contrary, the South Pole will be in Darknes. In this Case therefore, if it happen that the Sun be in the same Line with the Moon's Southern Limit, then will she, as she proceeds from Conjunction with the Sun towards her ascending Node, appear to dip her Northern Polar Parts a little into the dark Hemisphere, and to raise her Southern Polar Parts as much into the Light; and the contrary to this will happen the next Fortnight, while the New Moon is descending from her Northern Limit; for then her Northern Polar Parts will appear to emerge out of Darknes, and the Southern Polar Parts to dip into it. And this *seeming Libration*, or rather these Effects of the former *Libration in Latitude*, depending upon the Light of the Sun, will be compleated in her *Synodical Month*. *Greg. Astron. Lib. 4. Sect. 10.*

LICENCE [with *Painters*] is the Liberty which the Painter takes in dispensing with the Rules of Perspective, and the other Laws of his Art.

LICENSE *to arise*, is a Liberty given by the Court to a Tenant that is Effoined *de malo lecti* in a real Action: For the Law is, That in this Case he may not arise out of his Bed, or at least go out of his Chamber, until he have been viewed by Knights thereunto appointed, and have a Day assigned him to appear: And the Reason of this is, That it may appear whether he caused himself to be Effoined deceitfully, or not; and therefore if the Demandant can prove that he was seen abroad before the View or *Licence* of the Court, he shall be adjudged to be deceitfully Effoined, and to have made Default.

LICENTIA *Surgendi*, is a Writ whereby the Tenant Effoined *de malo lecti*, obtaineth Liberty to rise.

LICENTIA *Transfretandi*, is a Writ or War-rant directed to the Keepers of the Ports, willing

them to let some pass quietly beyond Sea, who have formerly obtained the King's Licence thereunto.

LICHEN, barbarously called by some *Serpigo* or *Zerma*: *Halliabbus* calls it *Petigo* and *Sarpedo*; the Vulgar *Voliacita*. *Lichens* are certain Asperities of the Skin, and as it were Tumours, which itch much, and send forth Matter. The *Greeks* and *Arabians* have made two sorts of *Lichens*; the one mild and gentle, the other fierce and cruel: And according to *Avicen*, some are moist; which being rubbed, send forth a kind of Dew; others are dry: And the Moist are more safe; but the Dry is made of salt pituitous Matter, turn'd into Melancholy Blood. And again he writes, That one *Impetigo* brings off the Skin, by reason of its great Dryness, and another does not; and that one is Ambulatory and Malignant, and another Fixed and Standing; as also one is Old, another Fresh. Hence it appears, That the *Scabies* of *Corn. Celsus* was nothing but these *Lichens* of the *Greeks*, and the *Impetigo*, of the *Arabians*. It comes in any Part of the Body but especially in the Face and Chin, as *Galen* has it: For a *Lichen*, says he, is a most ungrateful Distemper in the Chin, because, it makes it itch exceedingly, and stretches out the Parts affected: It is not a little dangerous; it spreads over the whole Face, and sometimes reaches the Eyes, and at last makes the Person affected extream filthy and loathsome. *Blanchard*.

LICHEN *of the Greeks*, is *Pliny's Impetigo*, or an Inequality of the Skin, extending it self to the neighbouring Parts, and accompanied with an extraordinary Itching, and dry Pimples. *Blanchard*.

LIE *under the Sea*: The Sailors say a Ship lies under the Sea, when her Helm being made fast *a-Lee*, she lies so *a-Hull*, that the Sea breaks upon her Bow, or her *Broad-side*.

LIEGE, is a Word borrowed from the *Feudists*, and hath two several Significations in the Common Law, sometimes being used for *Liege-Lord*, and sometimes for *Liege-Man*. *Liege-Lord*, is he that acknowledgeth no Superior; *Liege-Man*, is he that oweth Allegiance to his *Liege-Lord*.

LIEN, the same with *Spleen*; which see.

LIENTERIA, [*λιεντερία*] is a kind of Looseness, where the Meat or Aliment taken in, is sent out of the Body before it be altered, or at least before it be digested.

LIFE-RENT, in Law, is a Rent or Exhibition which a Man receives, either for Term of Life, or for Sustentation of Life.

LIFTING-PIECES, are Parts of a Clock which do lift up and unlock the Detents in the Clock-part.

LIFTS, are Ropes in a Ship belonging to the Yard-arms of all Yards: And their Use is to *Top the Yard-arms*, i. e. to make the Ends of the Yards hang higher or lower, as Occasion serves. The *Top sail Lifts* do serve as *Sheets* for the Top-gallant Yards, as well as for *Lifts* to the Top-sail Yards. The Haling of these Ropes is called *Topping the Lifts*: Thus they say, *Top a Starboard*, or *Top a Port*; i. e. hale upon the *Starboard* or *Larboard-Lift*.

The *Lifts* for the Sprit-sail Yard, they call *Standing-Lifts*.

LIGAMENT [*Ligamentum*] any thing that ties or binds one thing to another.

LIGAMENTUM: A *Ligament* is a solid and very fibrous Part of an Animal Body, proceeding almost from Matter like a *Cartilage*, different in Size, Number and Situation, broad and round, cold; as



it comes near the Constitution of a Membrane or a *Cartilage*, drier or moister, harder or softer, more or less, tough and flexible. Its Use is to connect the Parts, especially Bones, that they may better perform their Motions. Those which tie the Bones together are wholly insensible, and the others have but a dull Sense.

**LIGAMENTUM Ciliare:** See *Ciliare Ligamentum*.

**LIGATURE** [in Surgery] a Band or Fillet of Cloth or Linnen for binding the Arm and facilitating the Operation of letting Blood.

**LIGEANCY**, is such a Duty or Fealty as no Man may owe to more than one Lord; and therefore it is most commonly used for the Duty and Allegiance which every good Subject owes to his *Leige-Lord* the King.

*Ligeantia*, says my Lord Coke, *est duplex, sicut subditus tenetur Regi ad Obedientiam, ita Rex tenetur subdito ad Protectionem*: And in another Place, *Duplex est Ligamen inter Regem & populum, &c. Vid. 7 Rep. Calvin's Case* — Which Passages some will have to be an express Authority in Law, to prove the Original Contract between the King of England and the People.

**LIGHT**, is used to signify Three Things:

1. That Sensation which arises in us from the View of any Luminous Object, as the Sun, a Star, or a Candle.

2. *Light* signifies the Cause of that Sensation in us, as it is an Action or Property existing in the Luminous Body.

3. By this Word some also understand the *Action* of the *Medium* interposed between us and the Luminous Object; and others, That *Train of Rays*, which coming forth from thence, pervades the *Medium* before it can come to affect our Eyes.

*Light* is undoubtedly produced by Motion, but yet 'tis not every Motion that will produce *Light*. The Learned Dr. H. in his *Micrography*, P. 55. judges the Motion that produces *Light* ought to have these Requisites: 1. That it be *exceeding quick*, like the Motions of Fermentation and Putrefaction; as you see in shining Pickles and rotten Wood.) 2. It must be a *Vibrative Motion*, and also have its Vibrations exceeding short: This he concludes from the shining of Diamonds, when chafed or rubbed.

As to the Trajection of *Light* through the Medium, the most freely that can be, he well observes, 1. That the Medium must be susceptible and impartible of this Motion. 2. That the Parts of it must be Homogeneous. 3. That their Constitution be such, that *Light* may be propagated through them as soon as possible: Though he asserts, That it can by no Means be Instantaneous; and seems (so long ago) fully satisfied, That *Light* requires much the same Time for its Trajection, as Mr. Romer found it afterwards to do by the Eclipses of Jupiter's Satellites: See *Philos. Transf.* N. 136. P. 198.

The Incomparable Sir Isaac Newton allows, with other Astronomers, about 10 Minutes of an Hour for the Motion of a Ray of *Light* from the Sun to the Earth. *Princip.* P. 231.

He found also, by plain and repeated Experiments, That the Rays of *Light* being in the Air, and passing near or through the Edges of any opaque or transparent Body, (such as Pieces of Gold or Silver Coin, or square Pieces of those Metals; the Edges of Knives, or of broken Glass, &c.) are always *bent* or *incurvated* towards such Bodies, as if they were *attracted* by them; and of these, those

Rays which pass nearest the Edges, are most *incurvated*.

And from hence it will follow, That the Refraction of the Rays of *Light*, (especially of those which fall near the Edges of Bodies) is not made just at the Point of Incidence, but a little before the Rays enter into the denser Medium, and a little after they are gotten within it.

The same Person found also by curious Experiments made with *Prisms*, That the vividly coloured Image, transmitted through a Hole, in a darkened Room, opposite to the Sun-beams, and cast on a white Wall, was five times as long as it was broad: This strange Disproportion between the Length and Breadth of the coloured Spectrum put him upon several Thoughts; but at last he thought of this *Experimentum Crucis*: He took two Boards, and placed one close behind the Prism at the Window, so that the *Light* passing through a small Hole purposely made in it, might fall on another Board placed nearer the Wall, at about 12 Foot Distance from the former; and having also a small Hole in it too, for some of the incident *Light* to pass thro'. Behind this Board he placed a second Prism, that the Rays passing through it and the two Holes in the Boards, might be again refracted before it came to the Wall. Then he turned the first Prism at the Window slowly about its Axis, so as to make the several Parts of the Image cast on the second Board successively pass through the Hole in it, that so he might observe to what Places on the Wall the second Prism would refract them. And then he saw plainly, *by the Variation of those Places, that the Light tending to that End of the Image towards which the Refraction of the first Prism was made, did in the second Prism suffer a Refraction considerably, the Light tending to the other End.* And so the true Cause of the Length of that Image was detected to be no other, than that *Light consists of Rays differently refrangible*; which, without respect to any Difference in their Incidence, were according to their Degrees of Refrangibility transmitted towards divers Parts of the Wall. From whence he justly concluded, That *Light it self was an Heterogeneous Mixture of differently Refrangible Rays.* *Philosophical Transactions*, N. 80.

He demonstrates also, That since *Light* is always propagated in Right Lines, it cannot possibly consist in Action only, (*Prop.* 41, 42. *Lib. Princip. Phil. Mathem.*) as the *Cartesians* do assert.

In another Place of the *Transactions* he gives the following Definitions and Propositions.

#### DEFINITIONS.

1. *Homogeneous, Similar, or Uniform Light*, is that whose Rays are equally refrangible.

2. *Heterogeneous Light*, is that whose Rays are unequally refrangible.

*Note*, There are but Three Affections of *Light* in which he observed its Rays to differ; viz. *Refrangibility*, *Reflexibility*, and *Colour*: And those Rays which agree in *Refrangibility*, agree also in the other two; and therefore may well be defined *Homogeneous*, especially since Men usually call those things *Homogeneous*, which are so in all other Qualities that come under their Knowledge; though in other Qualities their Knowledge extends not to, there may possibly be some *Heterogeneity*.

3. Those *Colours* he calls *Simple* or *Homogeneous*, which are exhibited by *Homogeneous Light*.

4. And



4. And those Compound or *Homogeneous*, which are exhibited by *Homogeneous Light*.

5. Different Colours he calls not only the more eminent Species, Red, Yellow, Green, Blue, Purple, but all other the minutest Gradations; much after the same manner, that not only the more eminent Degree in Musick, but all the least Gradations are esteem'd different Sounds.

### PROPOSITIONS.

1. The Sun's *Light* consists of Rays differing by indefinite Degrees of Refrangibility.

2. Rays which differ in Refrangibility, when parted from one another, do proportionably differ in the Colours which they exhibit. These two Propositions are Matter of Fact.

3. There are as many Simple or Homogeneous Colours, as Degrees of Refrangibility; for to every Degree of Refrangibility belongs a different Colour, by *Prop. 2.* And that Colour is Simple, by *Def. 1. and 3.*

4. Whiteness, in all respects like that of the Sun's immediate *Light*, and of the usual Objects of our Senses, cannot be compounded of two simple Colours alone; for such a Composition must be made by Rays that have only two Degrees of Refrangibility, by *Def. 1. and 3.* And therefore it cannot be like that of the Sun's *Light*, by *Prop. 1.* Nor for the same Reason, like that of ordinary White Objects.

5. Whiteness, in all respects like that of the Sun's immediate *Light*, cannot be compounded of Simple Colours, without an indefinite Variety of them: For to such a Composition there are required Rays endued with all the indefinite Degrees of Refrangibility, by *Prop. 1.* And those infer as many Simple Colours, by *Def. 1. and 3. and Prop. 2. and 3.*

6. The Rays of *Light* do not act on one another, in passing through the same Medium.

7. The Rays of *Light* suffer not any Change of their Qualities from Refraction.

8. Nor afterwards from the adjacent quiet Medium. These two Propositions are manifest *de facto* in *Homogeneous Light*, whose Colour and Refrangibility is not at all changeable, either by Refraction, or by Contermination of the quiet Medium.

And as for *Heterogeneous Light*, it is but an Aggregate of several sorts of *Homogeneous Light*; no one sort of which suffers any more Alteration than if it were alone, because the Rays act not upon one another, by *Prop. 6.* and therefore the Aggregate can suffer none.

9. There can no homogeneous Colours be reduced out of *Light* by Refraction, which are not commixt in it before; because, by *Prop. 7 and 8,* Refraction changeth not the Qualities of the Rays, but only separates those which have divers Qualities, by means of their different Refrangibility.

10. The Sun's *Light* is an Aggregate of an indefinite Variety of homogeneous Colours, by *Prop. 1, 3, and 9.* And hence it is, that homogeneous Colours may be called Primitive or Original.

That *Light* is a Body, M. Molyneux, in his *Dioptricks*, proves from the various Properties of it: As,

1. By the Affection of its being *Refracted*, 'tis manifest, that *Light*, in its Passage through this and t'other Diaphanous Body, does find a *different Resistance*. Now 'tis unconceivable how any thing but Body should suffer *Resistance*; but we may conceive the Resistance that *Light* suffers in its Passage through different Diaphanous Bodies to proceed

from the Medium hindering the *Diffusion* or *Distribution* of *Light* through more of the Parts of this Medium, and consequently it may be said to be *less illuminable*: For from the Nature of it, *Light* endeavours to *diffuse* itself: And the contrary, by how much *Light* does more equally or uniformly affect the Parts of the Medium which it enlightens; or by how much it communicates its *Energy* to more of the *Particles* of the enlightened *Space*, that Medium may be said to be so much the *more illuminable*, or *less to resist* the Progress of *Light*. Whence it is, that by how much the affected Parts of the Medium are *more solid* and *small*, and admit between them the *less Space* for any other *Heterogeneous* Matter that suffers not by *Light*, by so much the Medium is said to be *more enlightened*.

And 'tis certain, That *Resistance* must proceed from the *Contact* of two Bodies; and *Contact*, either *Active* or *Passive*, belongs only to Body.

The Second Property that confirms *Light* to be a Body, and a Body moved or thrust forward, is, That it requires *Time* to pass from one Place to another, and does it not in an *Instant*, but is only of all Motions the *quickest*: For Mr. Romer has demonstrated, beyond all Contradiction, from the Observations of the *Immersion* and *Emergence* of the *Satellites* of *Jupiter*, That *Light* requires the Time of one Second to move the Space of 3000 Leagues, or 9000 Miles, which is near the Earth's Diameter; as may be seen in the *Journal des Savans*, 1676, Decemb. 7. *Philosophical Transactions*, N<sup>o</sup> 136. Or Sir Isaac Newton's *Philos. Natur. Math. Lib. 1. Schol. Prop. 96.* where 'tis asserted, That *Light* requires about 10 Minutes Time to come from the Sun to the Earth: And 'tis most evident, without this Allowance for the Time spent in *Light's* Motion, the Appearances of the *Satellites*, *Eclipses*, and *Immersion*s, are not to be explicated by any *Excentricity*, or other Hypothesis.

A third Proof that *Light* is a Body, is, That it cannot by any Art or Contrivance whatsoever, be *increas'd* or *diminish'd*; that is to say, we cannot magnify (for Instance) the *Light* of the Sun, or a Candle, no more than we can magnify a Cubick Inch of Gold, or make it more than a Cubick Inch: For whenever we see *Light* increased, 'tis by robbing it of some other Part of the Medium of its *Light*, or by bringing the *Light* that naturally should have been diffused through some other Part, to the more enlightened Place: Thus, for Instance, in a Burning-Glass, by which the *Light* of the Sun is highly increased in its *Focus*, or Burning-Point, we are first to consider, That in this *Focus* the Image of the Sun is projected, as being the *distinct* Base of the Glass: And Secondly, We may observe all round about this bright Spot of the Sun's Image, there is cast the strong Shadow of the whole Breadth of the Burning-Glass: For all the Rays from the Sun, that would have fallen on this broad shaded Space, are now brought together, and crowded close in this bright Spot, there raising a vigorous *Light* and violent Heat.

This is abundantly confirmed by an easy Experiment: For cover all the Burning-Glass, except one small round Space in its Middle, just the Bigness of the bright burning Spot in its Focus; and though there be a shaded Space round the bright Speck, as before, yet we shall not be sensible of any Increase either of *Light* or *Heat*; which plainly shews, That this Increase of *Light* (when the Glass is all bare) proceeds from the crowding together of those Rays that would have fallen on the rest of the Glass, and which (were not the Glass interposed)



interposed) would have fallen on the shaded Space round about the bright Speck.

There seems but one Objection against what is here laid down; and that is, That *Light* is *increased* by Reflexion, without depriving any Place of the *Light* it would otherwise receive; or without bringing to the enlightened Part any *Light* that would otherwise escape it, or never come at it. But if we consider the Matter more attentively, we shall find it otherwise: For suppose an *Hole* of a Foot Square in the Side of a Chamber, and that a Candle were placed close to, and just before the Middle of this *Hole*; there is but half this Candle that now enlightens this Room, the other half of its Rays proceeding directly out at the *Hole*: Let now a Looking-Glass be placed so, as just to fill up this *Hole*; the Rays which before would have gone out at the *Hole*, are now reflected into the Room; so that the Hemisphere without the Chamber, which was enlightened whilst the *Hole* continued open, is now robbed of its *Light*; and all this *Light* is now reflected into its Room, whereby the *averse* Side of the Flame is made to enlighten, as well as the Side *directly* exposed to the Chamber. What is said of this Case, may be accommodated to all: For so a Looking-Glass lying horizontally, and reflecting the Sun-beams to the Ceiling of the Room, does plainly hinder the direct Progress of the Rays to some other Part, and consequently robs that Part of its *Light*. This is evident, by supposing an *Hole* behind the Glass, as in the former Case.

From whence 'tis manifest, how vainly they attempt, who offer at *increasing Light uniformly*, that is, equally throughout the whole Sphere of a luminous Body, or radiating Point: Such are the Pretences of those that would persuade the World of Contrivances for making the small Flame of a Lamp enlighten *strongly* a whole Chapel, Hall, or Court, by being hung up in the midst thereof: For these Things are impossible to be effected in Nature, and they had as well pretend to create *Light*; for there is no other way of *increasing* it, unless by robbing another Place of its *Light*, and then 'tis not *uniformly increased*. We have a very sensible Instance of this in the *new invented Lanthorns*, now much used in *London*, which, by the Convex-Glasses in their Sides, do strongly throw those Rays along the Walks of the Passengers, which would otherwise (were the Glasses away, and the round Holes left open) be spent on Parts of the Streets not frequented; whereby the untrodden Parts of the Streets are robbed of their *Light*, more strongly to supply and enlighten the Paths where the *Light* is requisite.

The Intensity of *Light* (as also of *Heat*) is always proportionable to the Density of the Rays that produce it: And that Density always is in all Places, or at all Distances from the Center of Radiation, as the Squares of such Distances *reciprocally*. See *Quality*.

In the *French Memoirs* of the Royal Academy of Sciences, there is an Account of a New Theory of *Light*, which is started by M. *Malebranche*: He thinks *Light* and *Colours* do arise from Vibrations of the insensible Parts of Bodies, as Sounds do: And therefore, according to the Degree of the Rapidity of the Motion of the Parts of a luminous Body, it will appear enlightened more or less; and in lesser Degrees of such vibrating Motion, it will appear not luminous, but of such and such Colours.

LIGHT. In the *French Memoirs* of the Academy of Sciences, A. D. 1699, there are some Re-

flections about the Nature of Light and Colours, and of the Generation of Fire, by Mr. *Malebranche*; in which he endeavours to support his Notion before communicated in his *Recherches de la Verité*, and in his *Metaphysicks*, viz. That Light and Colours do consist only in the various *Pulses* or Vibrations of the Ethereal or Subtile Matter.

Dr. *Hook*, in his *Op. Posthuma*, p. 54. considering the exceeding Hardness of a Diamond, and its wonderful Property of emitting Light or shining in the Dark, upon being *rubbed* or *struck*, thinks that there is this one Essential Property necessary only to the Existence of Light, viz. *a very quick vibrative Motion*; for in this Experiment there is neither Combustion nor Flame, as in Fire; nor Moisture and Putrefaction, as in Fish, Flesh of Veal, rotten Wood, &c. nor a Motion of the Animal Spirits, (which some think to be the Cause of the Light in Glow-worms, the Eyes of Cats, &c.) essentially necessary to the Production of this Quality.

The same Author thinks that *Aristotle's* Definition of Light, *φῶς ἐστὶν ἡ ἐνεργεία τῆς διαφανέως*, That it is the inworking of the Diaphanous Body, or of the *Medium*, or the Internal Action of the Pellucid or Transparent Body, is the Light of which we are sensible, or which moves our Eye: So that he makes Light in the luminous Body to be a peculiar Motion of it, which the lucid Body can communicate to the transparent *Medium*, or to such a Body as is fit to propagate it. And Light in the Eye is this Motion impressed on it; by which the Soul becomes sensible of it.

P. 114. The Doctor asserts, That the Power or Force of Light decreases in a quadruplicate Ratio of the Distances reciprocally taken, or as the squared Squares of the Distances reciprocally; and consequently the Effect of Light, or the Motion it causes in other Bodies, will be in subduplicate Proportion of the Powers; and therefore only in duplicate Proportion of the Distances reciprocally taken.

P. 118. The Length of the Strokes of the Pulses of Light are in duplicate Proportion of the Distances reciprocally, pag. 121. Suppose then that the Length of the Pulse from the Centre outwards at the Body of the Sun should be one Inch, the Length of the Pulse of Light here with us would not be the 1000000th part of the thickness of a Hair; and yet is that amazing Organ, the Eye, so wisely contrived, as that the Strength of the Pulse, which was destroyed by so vast a Distance, is restored again to a good part of its first Power; for as in diverging Rays, the Length of the Pulse decreases in a duplicate Ratio of the Distance; so in converging Rays, it increases in that Ratio, and in a contrary Order.

I have before shewn from Sir *Isaac Newton*, that Light is propagated in Time; and he then supposed about 10 Minutes were taken up in its Passage from the Sun to us: But in his *Opticks* he determines this Matter more accurately. *Romer* first, and after him others, had observed that the Eclipses of *Jupiter's* Satellites happen about 7 or 8 Minutes sooner than they ought to do by the Tables, when the Earth is interposed between the Sun and that Planet; but as much later, when the Earth is beyond the Sun in respect of *Jupiter*: the Reason of which is, that the Light of the Satellites hath farther to go in the latter Case, than in the former, by the Diameter of the Earth's Orbit. Some Inequalities of Time indeed may arise from the Eccentricities of the Orbits of the Satellites; but these can't answer in all the Satellites, and at all times, to the Position and Distance of the Earth from the Sun.



Sun. The mean Motion of *Jupiter's* Satellites is also swifter in his Descent from his *Aphelium* to his *Perihelium*, than in his Ascent in the other half of his Orb. But this Inequality hath no respect to the Position of the Earth, and in the three interior Satellites is insensible, as he found by Computation from the Theory of their Gravity.

After this Sir *Isaac* advances this Proposition, which is the 12th of Part 3. of the second Book of his Opticks, viz.

*Every Ray of Light in its Passage through any refracting Substance is put into a certain transient Constitution or State, which in the Progress of the Ray returns at equal Intervals, and disposes the Ray at every Return to be easily transmitted thro' the next refracting Surface, and between the Returns to be easily reflected by it.* This is manifest from his 5, 9, 12 and 15th Observations. Whence it appears, that one and the same sort of Rays, at equal Angles of Incidence on any thin transparent Plate, is alternately reflected and transmitted for many Successions, according as the Thickness of the Plate increases in Arithmetical Progression of the Numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, &c. (See Colours.) And this alternate Reflection and Transmission, he found by his 24th Observation, continues for above 100 Vicissitudes; nay, as he proves afterwards, to many thousands; being propagated from one Surface of a Glass Plate to another, tho' the Thickness of the Plate be  $\frac{1}{4}$  of an Inch and more. So that this Alternation seems to be propagated from every refracting Surface to all Distances without End or Limitation. He shews also, that this alternate Reflection and Refraction depends on both the Surfaces of every thin Plate, because it depends on their Distance; but that it is performed at the second Surface. It is also influenced by some Action or Disposition propagated from the first to the second; because otherwise at the second it would not depend on the first: And this Action or Disposition, in its Propagation, intermits and returns by equal Intervals. What kind of Action or Disposition this is; whether it consist in a vibrating or a circulating Motion of the Ray, or of the Medium, or something else, the Author does not enquire: But he allows those that are averse to all new Discoveries which they can't explain by Hypotheses, at present to suppose, That as Stones by falling upon Water put it into an undulating Motion, and all Bodies by Percussion excite Vibrations in the Air; so the Rays of Light, by impinging on any refracting or reflecting Surface, excite Vibrations in the refracting or reflecting Medium; and by so doing do agitate the solid Parts of the refracting or reflecting Body; and by that Agitation cause the Body to grow warm or hot: That the Vibrations thus excited are propagated in the refracting or reflecting Medium or Substance, much after the manner that Vibrations are propagated in the Air for causing Sound; and that they move faster than the Rays, so as to overtake them; and that when any Ray is in that Part of the Vibration which conspires with its Motion, it easily breaks thro' a refracting Substance; but when it is in a contrary part of the Vibration, which impedes its Motion, it is easily reflected; and consequently, that every Ray is successively disposed to be easily reflected or transmitted by every Vibration which overtakes it. Whether this Hypothesis be true or false, he doth not consider at present, contenting himself with the Certainty of the Fact, That he hath discovered the Rays of Light by some Cause or other to be thus alternately disposed to be reflected or refracted

for many Vicissitudes. The Returns of this Disposition of any Ray to be reflected, he calls *Fits of easy Reflection*; and those of its Disposition to be transmitted, he calls *Fits of easy Transmission*; and the Space it puts between every Return and the next Return, he calls the *Intervals of its Fits*. Then at Prop. 13, he shews, that the Reason why the Surface of all thick transparent Bodies reflect part of the Light incident on them, and refract the rest, is that some Rays at their Incidence are in Fits of easy Reflection, and others in Fits of easy Transmission. This appears from his 24th Observation, where the Light reflected by thin Plates of Glass and Air; which to the naked Eye appeared evenly white all over, did thro' a Prism appear waved with many Successions of Light and Darkness, made by alternate Fits of easy Reflection and easy Transmission; the Prism severing and distinguishing the Waves of which the white Light was composed.

And hence 'tis plain, Light is in its Fits of easy Reflection and easy Transmission before its Incidence on any transparent Body: And probably it is put into such Fits at its first Emission from luminous Bodies, and continues in them during all its Progress. For these Fits are of a lasting Nature; as appears by what he proves elsewhere.

He supposes here the Transparent Bodies to be thick; because if the Thickness of the Body be much less than the Interval of the Fits of easy Reflection and easy Transmission of the Rays, the Body loseth its reflecting Power. For if the Rays, which at their entering into the Body are put into Fits of easy Transmission, arrive at the farthest Surface of the Body, before they be out of those Fits, they must be transmitted. And this is the Reason why Bubbles of Water lose their reflecting Power when they grow very thin, and why all Opake Bodies, when reduced into very small Parts, become Transparent.

He shews also, that those Surfaces of Transparent Bodies, which, if the Rays be in a Fit of Refraction, do refract it most strongly, if the Ray be in a Fit of Reflection, do reflect it most easily.

After this he gives several other curious Propositions; from whence he shews, that 'tis easy to collect the Intervals of the Fits of easy Reflection and easy Transmission of any sorts of Rays refracted in any Angle into any Medium, and thence to know, whether the Rays shall be reflected or transmitted at their sublequent Incidence on any Pellucid Medium.

By the Experiments and Observation about the Inflection of the Rays of Light (See Inflection) he makes it plain, that Bodies act on Light at a distance, and by that Action bend the Rays of it; and that this Action is strongest at the least distance. He shews also, that Rays which differ in Refrangibility differ also in Flexibility; and by their different Inflections it is that they are separated one from another, so far as after Separation to make the three Fringes of Colours mentioned in those Experiments: And 'tis probable the Rays of Light, in passing by the Edges and Sides of Bodies, are bent several times backwards and forwards with a Motion like that of an Eel; and that the said coloured Fringes of Light arise from three such Bendings. 'Tis probable also that the Rays of Light which fall upon Bodies, and by that means are reflected or refracted, begin to bend before they arrive at the Bodies; and that Light is reflected, refracted and inflected, by one and the same Principle acting variously in various Circumstances.



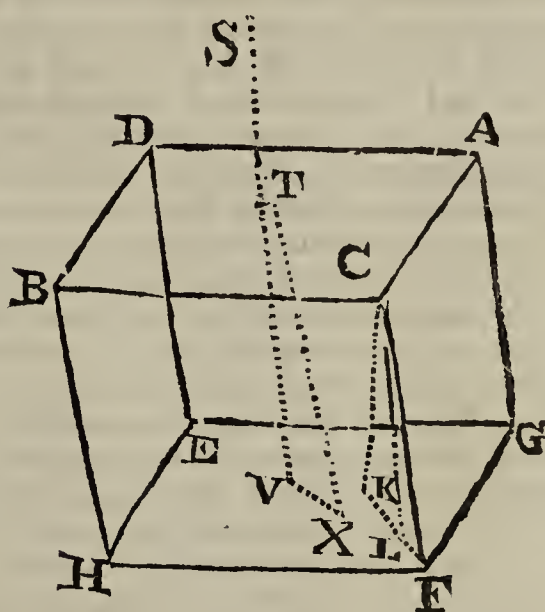
'Tis probable also, that Bodies and Light act mutually on one another: Bodies upon Light, in emitting, reflecting, refracting and inflecting it; and Light on Bodies, by *heating* them, and putting their Parts into a *vibrating Motion*, wherein Heat consists.

All *fix'd Bodies*, when heated beyond a certain degree, do emit *Light* and *shine*; and this *Shining* and Emission of Light is probably caused by the *vibrating* Motions of the Parts; and all Bodies abounding with Earthy Particles, and especially when they are sulphureous, when their Parts are sufficiently agitated, do emit Light; whether this Agitation be caused by *Attrition*, by Percussion, by Putrefaction, or a vital Motion in an Animal Body, &c. or any other way. Thus the Sea-water shines in a Storm; *Quicksilver* when *shaken in Vacuo*; a Cat's Back, or a Horse's Neck, rubb'd by the Hand in the dark; Wood, Flesh and Fish, when putrified.

The same admirable Author, in the new *Queries* annexed to the *Latin* Edition of his *Opticks*, thinks it probable, that there are yet some other *congenite Properties* of the Rays of Light besides those above described; one of which the Refraction of that strange Body *Island Chrystal* acquaints us with. This was first taken notice of by *Erasmus Bartholinus*, but afterwards more accurately described by *Hugens* in his Book of *Light*, written in *French*. This Chrystal is a pellucid and fissil Stone, equaling Rock Chrystal or clear Water in Transparency; 'twill bear being white hot in the Fire, and after that will lose its Transparency: By a very violent Heat it's reduced to a *Calx*, but will not melt nor run: Being macerated for a Day or two in Water, it also loses its natural Politure; on rubbing, it discovers an *Electrick* Quality, and with *Aqua fortis* makes an Ebullition. It seems to be a kind of Talk. If a piece of this Chrystal be laid upon the Leaf of a Book, each Letter seen thro' the Chrystal, by a kind of double Reflection, appears double: And if any Ray of Light fall on any of its Surfaces, either perpendicularly or obliquely, it is always divided by a double Refraction into two Rays; each of which is of the same Colour with the Incident Ray, and they appear equal to one another as to the Quality of Light. One of these two Refractions is conformable to the known Laws of Opticks; *viz.* That the Sine of the Incidence out of Air into the Chrystal is to the Sine of Refraction: as 5 is to 3. But the other, which may be called the *Unusual Refraction*, is made thus: Let *A D B C* be the Surface of the Refracting Chrystal, *C* the greatest solid Angle belonging to that Surface: Let *G E H F* be the opposite Surface, to which the Line *C K* is perpendicular: This Perpendicular with the Line *C F* representing the extrem Edge of the Chrystal contain an Angle of  $19^{\circ}. 3'$ . Join *K F*; in which take *K L* so, that the Angle *K C L* may be of  $6^{\circ}. 40'$ . but the Angle *L C F* of  $12^{\circ}. 23'$ . This being done, let the Line *S T* represent any Incident Ray of Light in the Point *T*; let *T V* be the refracted Ray; and what that is may be found by the given Ratio of the Sines of 5 to 3, according to the common Laws of Opticks. Then draw *V X* parallel and equal to *K L*, and so posited that it may lie the same way towards *V*, as *L* doth in respect of *K*. Join *T X*; and that Line *T X* shall be the *unusual Refracted Ray*, being carried by the new Refraction from *T* to *X*. If then the Incident Ray *S T* fall also perpendicularly on the Refracting Surface, those two Rays *T V*, and *T X*, into

which by Refraction it is divided, will become parallel to the two Lines *C K* and *C L*: and the other Ray will be transmitted perpendicularly, according to the common Laws of Opticks; and the other (*viz.* *T X*) diverging by this unusual Refraction from the Perpendicular, will make with it the Angle *V T X* of about 6 degr. as is found by Experience.

And hence the Plane *T V X*, and such like similar Planes, which are parallel to the Plane *C F K*, may be called the *Planes of Perpendicular Refraction*; and that Part, Side or Place towards which the Lines *K L* and *V X* tend, and which are drawn from the Points *K* and *V*, may be called the *Part, Place, or Side of Unusual Refraction*.



In like manner *Rock Chrystal* hath a double Refraction; but the Difference between the two Refractions is less and less conspicuous, than in the *Island Chrystal*.

When the Ray *S T*, which falling on the first Surface of the *Island Chrystal*, is divided into the two Rays *T V*, and *T X*; and those two Rays come to the latter Surface of the said Chrystal; then the Ray *T X*, which in the first Superficies is refracted in the *unusual Ratio*, will be again refracted entire with the same *unusual Ratio*, so that these two Rays will emerge out of the second Surface in Lines parallel to the first incident Ray *S T*. For the same will happen also as to the Ray *T V*, which being refracted in the first Surface with the *usual Ratio*, will also be again refracted at the second with the *usual Ratio*.

And if of two pieces of *Island Chrystal*; one be so placed after another, that all the Surfaces of the latter be respectively parallel to those of the former: Now also those Rays, which in the first Surface of the first Chrystal were refracted with the *usual Ratio*, shall in all the latter Surfaces be refracted with the same *usual Ratio*; and those Rays, which in the first Surface of the former Chrystal were refracted with the *unusual Ratio*, shall in all the latter Surfaces be refracted with the *unusual Ratio*: And the same thing will come to pass when the Surface of the two Chrystals are inclined one to another, so their *Planes of Perpendicular Refraction* be but parallel.

There is therefore some *congenite Difference* in the Rays of Light, that occasions, as in this Experiment, some of them to be refracted in the *usual Ratio* always, and others always in the *unusual Ratio*; for if it were not *congenite*, but did arise from some *new Modifications* impressed on the Rays in the first Refraction, then that would be changed by the same kind of new Modifications.



in the three following Refractions. But no such thing happens: But the Property continues always the same, and hath the very same Effect in the Rays in all those Refractions: Wherefore this *unusual Refraction* must depend on some *congenite Property* in the Rays of Light. And 'tis very well worth while to enquire, whether there may not be *other such*, as yet unobserved and unknown.

For one would suspect that there are *divers Sides* of the Rays of Light, and those endued with *divers congenite Properties*: For if the *Planes of Perpendicular Refraction* of the second piece of Chrystal be placed at Right Angles with the *Planes of Perpendicular Refraction* of the first Chrystal; then will the Rays, which in their Projection thro' the first Chrystal were refracted with the *usual Ratio* in passing through the second be refracted with the *unusual Ratio*; and those Rays, which in passing thro' the first Chrystal were refracted with the *unusual Ratio*, shall in passing through the second be refracted with the *usual Ratio*. Wherefore there are not two divers kinds of Rays in their own Nature different; of which one sort are always and in all Positions refracted with the *usual*, and others with the *unusual Ratio*: But these two kinds of Rays, as mentioned in the last Experiment, did only differ in this, that the Rays, according to their different Position, did with their different Sides respect the *Place, Region or Side of unusual Refraction* in the Chrystal: For in the present Experiment, one and the same Ray is refracted one way with the *usual*, the other way with the *unusual Ratio*, according to the Position of its Sides to those of the Chrystal. If the same *Sides* of any Ray look towards the same Parts of each Chrystal, then will that Ray be refracted with *one and the same Ratio* in each Chrystal; but if that Side of the Ray, which is turned towards the *Place of unusual Refraction* in the former Chrystal, be distant  $90^\circ$ . from that Side of the same Ray which looks towards the *Place of unusual Refraction* of the second Chrystal (which may be done, by so turning the second Chrystal, that it shall look towards the former Chrystal, and consequently the Rays of Light themselves in a different Position) that Ray will now be refracted in different Ratio's in the different Chrystals. So that you may determine, whether the Rays, which fall on the second Chrystal, will be refracted in the *usual* or *unusual Ratio*. And for this there is nothing more required, than that the second Chrystal be so turned about, that its *Place or Region of unusual Refraction* be accordingly posited on this or that Side of the Ray.

Wherefore every Ray may be considered as having four Sides; two of which being directly opposite to one another, cause that the Ray be always refracted in the *unusual Ratio*, whenever either of those Sides is turned towards the Side or Place of *unusual Refraction* in the Chrystal: But the other two Sides, as often as either of them is turned towards the Side of *unusual Refraction* in the Chrystal, do yet *cause* the Ray to be refracted with the *usual Ratio*. The two former Sides of the Ray therefore may be called the *Sides of unusual*, the two latter of *usual Refraction*. And because these *Dispositions* were in the Rays before they fell on the 2d, 3d, and 4th Surface of the 2 Chrystals, nor were they at all changed by the Refraction of the Rays in their Passage thro' those Surfaces, but the Rays were refracted by one and the same Law in every one of the four Surfaces, it seems that these *Dispositions* are properly *congenite* to the Rays of Light, and were not at all changed by the first

Refraction; but that it is on the account of these *Dispositions* in the Rays, that they were refracted in their Incidence on the *first Surface* of the *first Chrystal*, some in the *usual*, and some in the *unusual Ratio*, according as their *Sides of usual or unusual Refraction* at that time respected the Sides or Place of *unusual Refraction* in that Chrystal.

All the Rays of Light therefore have two opposite Sides, in which the *Property is congenite*, on which the *unusual Refraction* depends; and the other two Sides are *without* any such *Property*. And it requires yet further to be considered, whether there be not even *other Properties of Light*, by which the Sides of the Rays *differ*, and are *distinguished* from one another.

After this he shews, that in an *Oblique Incidence* of the Rays upon the *first Chrystal*, the same *Difference* between them appears, as when they fall *perpendicularly* to the former Properties.

From the whole therefore may be very justly concluded, That all those *Hypotheses* are false and precarious which have been yet advanced, in order to explain the *Phænomena* of Light by *new Modifications of the Rays*; for they do not depend on any such *Modifications*, but on *congenite and immutable Properties*, essentially inherent in the Rays.

And equally erroneous also are those *Hypotheses*, which attempt to explain the *Phænomena* of Light by any *Pressure or Pulse* impressed upon the *fluid Medium* by Motion; for these at long run depend upon the *new and different Modifications* of the Rays, and so fall in with the other.

But further, if Light consisted only in a *Pressure* upon the *Medium*, it must be either without any *local Motion*; and then 'tis impossible to account for the Agitation and Heat produced in Bodies by the Refraction and Reflection of the Rays: Or if it be supposed to consist in Motion propagated to all Distances in an Instant, to that must be required an *infinite Force* acting every Moment, and in each lucid Particle. But did Light consist in a *Pressure* or a *Motion* propagated thro' a *fluid Medium*, whether it be propagated instantaneously, or in time, it could not be done in Right Lines, but must inflect back upon itself in a Shadow; for *Pressure* or *Motion* in a fluid Medium, whenever it meets with any Obstacle which may impede Part of its Motion, cannot be propagated in *Right Lines*, but must be inflected back towards itself, and diffused every way throughout the *quiescent Medium* which lies beyond the Obstacle.

The Force of Gravity tends downwards; and yet the Pressure of the Parts of Water, which arises only from the Force of Gravity, tends with an equable Force every way, and is propagated with equal Ease by crooked Lines as by strait. Waves, on the Surface of Water, where they fall on the Surface of any large Obstacle, inflect back upon themselves, and are dilated and diffused gradually in the quiescent Water lying beyond that Obstacle. The Waves, Vibrations, or Pulses of Air, in which Sounds consist, are manifestly inflected, though not so much as those of Water; for the Sound of a Bell, or of a great Gun, can be heard over a Hill, interposed between the Ear and Eye, and sounding Body: And we find that Sound is propagated as easily by crooked as strait Tubes; whereas Light is never observed to move in curve Lines, nor to be inflected back so as to shadow itself. Indeed there is a kind of Inflection of the Rays of Light, as hath been before mentioned; but that is not *ad Umbram*, but a contrary way, and is only found in a Ray's passing by and very



very near the extream Edge of some Body; and then as soon as it is past the Body, it goes on *strait* again.

The *Rays of Light* are therefore certainly *little Particles*, actually emitted from the *Lucent Body*, and *refracted* by some *Attraction*, by which *Light*, and the *Bodies* on which it falls, do mutually act upon one another; for such Particles or Corpuscles thro' uniform Mediums will be transmitted in right Lines without any Inflection in *Umbram*, as we find the Rays of Light are: They may have also *divers Properties*, and which they may preserve immutable in their own Passages thro' divers Mediums; which agrees with the Nature of the Rays of Light. *Pellucid Bodies* act upon the Rays of Light at *some Distance*, when they refract, reflect and inflect them; and the Rays of Light reciprocally act upon them, at some little Distance also, by agitating and heating their Particles. And this *Action* and *Re-action*, which is performed at *some Distance*, is mighty like what we call the *Force of Attraction*, or *Gravity*, in other Bodies. And if the Cause of *Refraction* be the *Attraction* of the Rays, he shews in his admirable *Principia*, that the *Sines of Incidence must be to the Sines of Refraction in a given Ratio*; as in Fact we find the thing to be. The Rays of Light, in passing out of Glass into a *Vacuum*, are *inflected* towards the Glass, and, if they fall too obliquely, will revert back again to the Glass, and *be totally reflected*. Now the Cause of this Reflection cannot be attributed to any Resistance of the *Void* or *Vacuum*, but entirely to some *Force* or *Power* in the Glass, which attracts or draws back again the Rays as they are passing into the *Vacuum*. And this appears from hence, That if you wet the posterior Surface of the Glass with Water, Oil, or liquid and clear Honey, or with a Solution of Quicksilver; then the Rays, which would otherwise have been *reflected*, will pass into and thro' that Liquor. Which plainly shews, that the Rays are not reflected till they come to that *posterior Surface* of the Glass, nor till they begin to *go out* of it too. But if at their going out they fall into any of the aforesaid Liquors, they will then not be *reflected*, but *go on* in their *former Course*; the Reason of which is, that the *Attraction* of the Glass is counter-balanced by the *Attraction* of the Parts of the Liquor which adhere to its Surface. And this appears yet plainer in the Experiment of two Glass Prisms, or the Object Glasses of two long Telescopes, one of which shall be plane (on one side), the other a little convex, and then compressing them so that they do neither quite touch one another throughout, and yet have their Surfaces very near; for then that Light which falls on the hinder Surface of the first Glass, and in that Place where the Glasses are not distant one from another above  $\frac{1}{1000}$  of an Inch, will be totally transmitted thro' that Surface and the interjected Air or Vacuity, and will enter into the second Glass (as he shews in his 1st, 4th, and 8th Observations of the first Part of his 2d Book of his *Opticks*). But if the second Glass be moved a little farther off, then the Light, coming out of the hinder Surface of the first Glass into that Air or *Vacuum*, will be turned back again towards the Glass, and reflected. Wherefore 'tis plain, that the Rays are drawn back by some *Force* that is inherent in the first Glass, since there is nothing else that can occasion it.

To account also for that odd *Phænomenon* of the Rays of Light, which he calls *their Fits of easy*

*Transmission and Reflection*, he judges that there is nothing more required, than that the Rays should be very small Corpuscles of Matter, which either by their *Attraction*, or *some other Force*, do excite certain *Vibrations* in the Bodies on which they act; which Vibrations, being *swifter* than the *Motion of the Rays*, do successively outstrip or get before them, and so agitate them as alternately to increase or diminish their Velocity; and therefore produce those *Fits* in the Rays of Light.

And he thinks it very likely, that the *Unusual Refraction*, discovered to be in the *Island Chrystal* above-mentioned, is caused by some *Attracting Force*, which is inherent in certain *Sides* of the Rays and of the *Particles* of the Chrystal. For if there were not some such *Force* or *Virtue* in some Part of the Chrystal, and not in the others, in order to distort and bend the Rays towards the Sides or Parts of *Unusual Refraction*, it could not be, that the Rays, which fall perpendicularly upon the Chrystal, should both in their Ingress and Egress be so refracted one way rather than another, as that they should also perpendicularly emerge by a now contrary Position of the *Place* or *Region of Unusual Refraction* in the Surface of the second Chrystal; the Chrystal plainly acting upon the Rays *after* they have passed thro' it, and are got into the Air, or into a *Vacuum*.

And because the Chrystal, by that Force, doth not act on the Rays, but when the proper corresponding Sides of the Rays of Light are turned towards the Places or Parts of *Unusual Refraction* in the Chrystal, it appears that there is also some Force or Virtue in the Sides of the Rays themselves, corresponding to that Force inherent in those Parts of the Chrystal, almost after the same manner as the two Poles of the Magnet answer to one another. Which Virtue in the Magnet, as it is capable of being increased and diminished, and is not any where to be found but in the Magnet and in Iron; so this Virtue of the refracting Rays which fall perpendicularly upon it, is greater in the *Island* than in the *Rock Chrystal*, and is as yet found no where else.

Not that he thinks this Virtue to be *Magnetical*; for it seems to be of a different Nature. But let it be what it will, it can scarce be conceived that the Rays of Light, unless they be allowed to be really Corpuscles or Particles of Matter, can have any such permanent *Force* in two of their Sides; and not have any such thing, at the same time, in their two other; and this without any regard to the *Position* with which they respect the Space or *Medium* thro' which they pass.

And yet tho' Light be certainly a Body, it is almost impossible to conceive the Smallness of its Corpuscles. But however, that they are exceeding minute, may be gathered from these Considerations: (1.) That they freely pervade all transparent Bodies, such as Chrystal, Glass, several Pebbles and Gems; and almost all Fluids, but Mercury; and pass where no other Fluid, how thin soever, can enter; and yet no Eye hath ever been able to discover the constituent Particles of the grossest Fluid. (2.) It may be propagated from innumerable different *Luminous Bodies*, without any considerable Opposition to one another, as Dr. Cheyne shews by this Experiment: Suppose a Plate of Metal, having at the top the smallest Hole that can be made, were erected *perpendicularly* on an *Horizontal Plane*, and that about it were set



innumerable *luminous Objects* of about the same Height with the Plate, at an ordinary Distance from it; then will the Light, proceeding from every one of these Objects, be propagated through this small Hole, without interfering. This will appear by applying a dark Object, in a strait Line, against the luminous Body; for the Light of this Body will, thro' the Hole, be received upon the dark Body. Now it is impossible that so many different *Streams* of Light could be transmitted thro' so small a Hole, were not the Particles of Light extremely little. To which may be added, (3.) That if they were not very minute Corpuscles, their amazing Velocity is such, that they would pierce through all Kinds of solid Bodies almost as easily as they do Vacuities; whereas we see the Rays of Light to be regularly reflected from some Bodies. (4.) We find also that innumerable different Spheres of Light may be propagated from their several luminous Centres within our Horizon, without interfering. How many Millions of Candles and Flambeauxs, sending all out their Tides of Light, is it possible for the Eye to see together, without their being confounded one with another? Which shews both the exceeding Smallness of the Particles of Light, and also the Largeness of the Vacuities between the Particles of Air and other Bodies.

How extremely swift the Particles of Light move, may be gathered from the Experiment of Mr. *Romer*, wherein he finds that the Rays of Light pass from the Sun to us in about 10 Minutes of Time: And Mr. *Hugens* hath proved in his *Cosmotheoros*, that a Bullet discharged from the Mouth of a Cannon, and not abating of its first Velocity, would be 25 Years before it reach the Sun. Now the *Via percurfa* being the same in both, the *Velocities* will be reciprocally as the Times; that is, the Velocity of Light to that of Cannon-Bullet, will be to that of a Cannon-Bullet, persisting in its greatest Swiftmess, as 25 Years to 10 Minutes; or as 1314700 is to one, nearly: So that the Motion of Light is above a Million of times swifter than that of a Cannon Ball.

Moreover, the Distance between the Sun and Earth is at least 12000 Diameters of the Earth; but suppose it but 10000, then will Light run 1000 Diameters in a Minute, or  $16\frac{1}{2}$  Diameters in a Second; that is, at least 130000 Miles in one Second; which is Motion almost incredibly and really amazingly swift. But the extraordinary Effects of Light and Heat seem to require all this; and we see how powerfully it acts (being congregated) on the most compact solid Bodies; and we never find any Abatement of its Force arising from a Diminution of its Velocity.

See Mr. *Hauksbee's* Experiments about the Production of Light in *Vacuo* by the Attrition of Bodies, in *Phil. Transf.* N<sup>o</sup> 304, and in N<sup>o</sup> 307; and by the Effluvia of one Glass falling on another in Motion, *Phil. Transf.* N<sup>o</sup> 309, 310.

This is a Phænomenon that has employ'd the nicest Enquiries of very great Philosophers, so that there has been a great deal said thereupon; but it sufficeth for our purpose to know, that it is really a Body, tho' in extremely small Particles. Mr. *Romer* first demonstrated from Observations on the Eclipses of the Satellites of *Jupiter*, that its Progress from the Sun to our Earth is not above 10 Minutes: Since therefore the Earth is at least 100000 of its own Diameters distant from the Sun, therefore must the Light run 1000 of these Diameters in a Minute, which is above 100000 Miles in a Second: And if a Bullet moving with the same Celerity with which it leaves the Muzzle of a Can-

non, requires 25 Years to pass from the Earth to the Sun, as *Hugens* has computed, then will the Velocity of Light to that of a Cannon Ball, be as 25 Years to 10 Minutes, which is above 1000000 to 1; so that the Particles of Light move above a Million of times swifter than a Cannon Bullet; from which great Rapidity of Motion, very strange Effects may be expected; for the *Momentum* of any Body in Motion against another, is as a Rectangle under the Magnitude and Celerity of the moved Body; and this is surprisingly enough manifest in the common Effects of a Burning-Glass, how great a Force they have when collected by such a Contrivance into a small Compass of Action. Dr. *Hook* has demonstrated that the Power or Force of Light decreases in a quadruplicate Ratio of the Distances reciprocally, or as the squared Squares of the Distances reciprocally taken; and consequently that the Effect of Light, or the Motion it causes in other Bodies, will be in a subduplicate Proportion of the Powers, and therefore only in a duplicate Proportion of the Distances reciprocally taken: He has shewn also, That the Length of the Strokes of the Pulses of Light are in a duplicate Proportion of their Distances reciprocally. Suppose then that the Length of the Pulse from the Centre outwards at the Body of the Sun should be one Inch, the Length of the Pulse of Light here with us, would not be the 1000000th Part of the Thickness of an Hair; yet the Eye is so contrived, that the Strength of the Pulse which was destroyed by so great a Distance, is restored again to a good measure of its first Power; for as in diverging Rays the Length of the Pulse decreases in a duplicate Ratio of the Distance, so in converging Rays it increases in that Ratio, and in a contrary Order. Hence we may pronounce, that Light is always proportionable to the Density of Rays that produce it; and that Density always is in all Places, or at all Distances from the Centre of Radiation, as the Squares of such Distances reciprocally. From whence it is manifest, how vainly they attempt, who pretend to increase Light uniformly, that is, equally throughout the whole Sphere of the luminous Body or radiating Point. It is probable also, that Bodies and Light act mutually upon one another; Bodies upon Light, in emitting, reflecting, refracting, and inflecting it; and Light on Bodies, by heating them, and putting their Parts into a vibrating Motion; wherein Heat, in a great measure, consists; for all fix'd Bodies, when heated beyond a certain Degree, do emit Light and shine; and this Shining and Emission of Light, is probably caused by the vibrating Motions of the Parts; and all Bodies abounding with earthy Particles, and especially if they are sulphurous, and their Parts sufficiently agitated, do emit Light whatsoever way such Agitation is brought about: Thus Sea Water shines in a Storm, Quicksilver when shaken in *Vacuo*; Cats or Horses when rubb'd in the Dark; and Wood, Fish, or Flesh, when putrify'd. For a further Account hereof, and its physical Effects on other Bodies, see Dr. *Hook's Opera Posthuma*, *Molyneux's Opticks*, Reflexions of *Malbranche* in the *French Memoirs* of the Academy of Sciences, A. D. 1699. *Cheyne's* Mathematical Principles of Natural Religion, Sir *Is. Newton's Opticks*, *Hauksbee's* Experiments before the Royal Society, and others.

**LIGHTS.** Ships of War are in the Night-time very well distinguished by the *Lights* that they hang out; for in a Fleet the Admiral carries three *Lights* on the Poop, and one on the Main-Top; the Vice-Admiral hath two on his Poop, and one on



on his Main-Top; the Rear-Admiral hath but one on his Poop, and one on his Main-Top; the Vice-Admiral of each particular Squadron hath only two on his Poop, but none on his Main-Top; the Rear-Admiral of each Squadron hath only one on his Poop. But when the whole Fleet carry their *Lights*, then the Rear-Admiral is distinguished by carrying two *Lights*, the one hoisted a Yard above the other, on the Ensign-Staff; and in case of foul Weather and a dark Night, every Ship must carry a *Light*.

**LIGHTS** [with *Architects*] are the Apertures of a Building; the Gates, Doors, Windows, and other Openings through which the *Air* and *Light* have a Passage.

**LIGHTS** [in *Painting*] are those Parts of a Piece that are illumined, or that lie open to the Luminary, by which the Piece is supposed to be enlightened, and for that Cause are painted in bright vivid Colours; and in this Sense Light is oppos'd to Shadow.

**LIGULA**, in our *Latin* Law, signifies a Copy, Exemplification, or Transcript of any Court Roll or Deed.

**LIKE** *Quantities*, in *Algebra*, are such as are express'd by the same Letters equally repeated in each Quantity. Thus  $2b$  and  $3b$ , and  $9ff$  and  $3ff$ , are like *Quantities*; but  $2b$  and  $3bb$ , and  $9ff$  and  $3fff$ , are unlike ones; because the Quantities have not every where the same Dimensions, nor are the Letters equally repeated.

**LIKE** *Signs*, in *Algebra*, are when both are Affirmative, or both Negative; but if one be Affirmative, and the other Negative, they are unlike *Signs*. Thus  $+64d$  and  $+5d$  have like *Signs*; but  $9ff$  and  $-7ff$  have unlike *Signs*.

**LIKE** *Figures*, in *Geometry*, are such as have their Angles equal, and the Sides about these equal Angles proportional.

**LIKE** *Arks*, in the Projection of the Sphere in *Plano*, are Parts of Lesser Circles, containing an equal Number of Degrees with the corresponding Arks of Greater ones.

**LIKE** *Solid Figures*, in *Geometry*, are such as are contained under like Planes, equal in Number.

**LIMB**, signifies the outermost Border or graduated Edge of an *Astrolabe*, or the like Mathematical Instrument; or the Circumference of the primitive Circle in any Projection of the Sphere in *Plano*: Also the outermost Border of the Sun's or Moon's Disk in an Eclipse of either Luminary.

**LIMBER** *Holes*, in a Ship, are little square Holes cut in the Bottom of all her Ground-timber and Hooks, about 3 or 4 Inches square: Their Use is to let the Water to the Well of the Pump, which else would rest between those Timbers where the Keel-Rode runs.

**LIMBERS**, in *Gunnery*, are a kind of Train joined to the Carriage of a Cannon upon a March. It is composed of two Shafts wide enough to receive a Horse between them (which Horse is called the *Fillet Horse*.) These Shafts are joined by two Bars of Wood and a Bolt of Iron at the end, and have a pair of small Wheels: On the Axle-tree rises a strong Iron Spike, on which the Train of the Carriage is put upon a March: But when a Gun is on Action, these *Limbers* are run out behind her.

**LIMIT** of a Planet, is the greatest heliocentrick Latitude; which see.

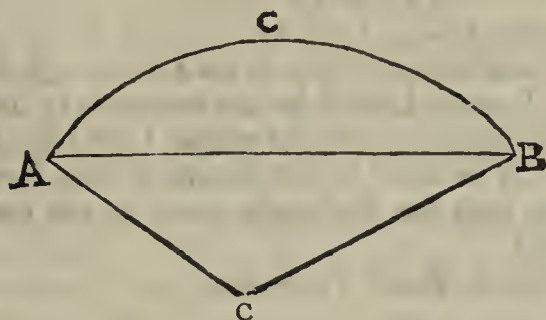
**LIMITATION** of *Affize*, is a certain Time set down by Statute, wherein a Man must alledge himself, or his Ancestor, to have been seized of Lands, sued for by a Writ of Affize.

**LIMITED** *Problem*, (for so I translate Mr. Ozanam's Word *Ordonne*) signifies a Problem that hath but one only Solution, or which can be done but one only way; as to make a Circle pass through 3 Points given, not lying in a Right Line; to describe an Equilateral Triangle on a Line given.

**LINCH** Pins, are those Pins that keep on the Trucks or Wheels on the Carriage of a Piece of Ordnance.

**LINCTUS**, the same with *Eclegma*; which see.

**LINE**: A Line in Geometry, is a Quantity extended in Length only, and is supposed to have no Breadth or Thickness. It is made by the Motion of a Point; as if the Point *A* be moved towards *B*, it



will by its Motion trace out or describe a *Line*; which, if it go the nearest way between *A* and *B*, will be a *Right* or *Straight Line*, whose Definition therefore will be the *nearest or shortest Distance between any two Points*. But if the Point go any way about, as in any of the Lines *ACB*, then it will trace out either a *Crooked Line*, as the upper *ACB*, or else two or more *Straight Ones*, as in the lower *ACB*.

From which Genesis or Production of a Line, several Consequences will fairly follow; some of which are needless Propositions in *Euclid*.

1. Two Right Lines cannot include a Space; but if drawn from the same Point to the same Point, will always be *coincident*; and drawn any how else, can only meet and make an Angle, but can never bound or terminate a Space. *Axiom 14. 1 Euclid.*

2. In any Triangle, as *ACB*, any two Sides, as *AC* and *CB* taken together, are longer than the third *AB*; because *AB* is the shortest Distance between the two Points *A* and *B*. *20 e. 1 Euclid.*

3. A Tangent (or Line touching the Circumference of a Circle) can touch it but in one Point, and consequently will be all of it without the Circle. *16 e. 3 Euclid.*

4. A Right Line drawn between any two Points in the Circumference of a Circle, falls all within the Circle. *2 e. 3 Euclid.*

**LINE** of *Measures*, so Mr. Oughtred calls the Diameter of the primitive Circle in the *Projection of the Sphere in Plano*; or that Line in which the Diameter of any Circle to be projected falls.

**LINE** of *Numbers*, is a Line so called by its Inventor Mr. Gunter, and therefore frequently called *Gunter's Line*. This is usually placed on a Ruler, or the Back of a Sector; and running parallel with it, you have the *Artificial Lines*, as we usually call them.

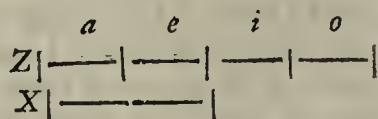
**LINES** and their *Properties*.

The Second Book of *Euclid* treats mostly of Lines, and of the Effects of their being divided, and then multiplied into one another; as also do the first six Propositions of Book the 13th. The former of which you have here very briefly demonstrated algebraically.

1. If there be two Lines  $z$  and  $x$ ; one of which, as  $z$ , is divided into any Number of Parts, as into  $a + e + i + o$ , the Rectangle under the two whole



Lines  $zx$ , is equal to the Sum of all the Rectangles made by  $x$  multiplied into the Parts of  $z$ .



That is,  $zx = xa + xe + xi + xe$ . This is so plain, it needs no Proof.

2. If a Right Line, as  $z$ , be divided into two Parts  $a + e$ , the Rectangles made by the whole Line, and both its Parts, are equal to the Square of the whole Line: see Fig. 2.

That is,  $za + ze = zz$ .

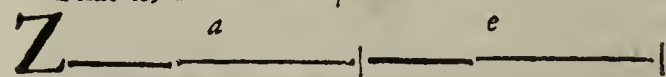
For  $za = aa + ae$ .

And  $ze = ae + ee$ .

Therefore  $zz = aa + 2ae + ee$ . Q. E. D.

3. Let the Line  $Z$  be cut into  $a + e$ ; then shall the Rectangle under the whole Line ( $Z$ ) and the Part ( $a$ ) be equal to the Square of that Part  $a$ , together with the Rectangle made by the two Parts  $a$  and  $e$ .

That is,  $Za = aa + ae$ .



For  $Z = a + e$

And  $\frac{a+e}{a+e} \times a = aa + ae$ . Q. E. D.

4. The Square of any Line, as  $Z$ , divided into any two Parts  $a$  and  $e$ , is equal to both the Squares of those Parts together, with the Rectangles made out of those Parts.

That is,  $ZZ = aa + 2ae + ee$ .

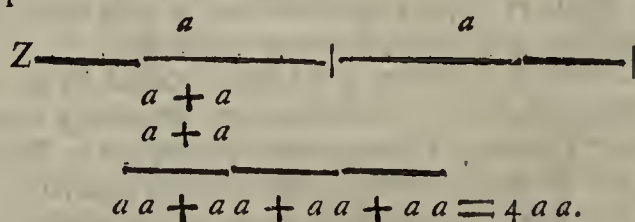


Multiply  $a + e$  by itself, and the Thing is plain.

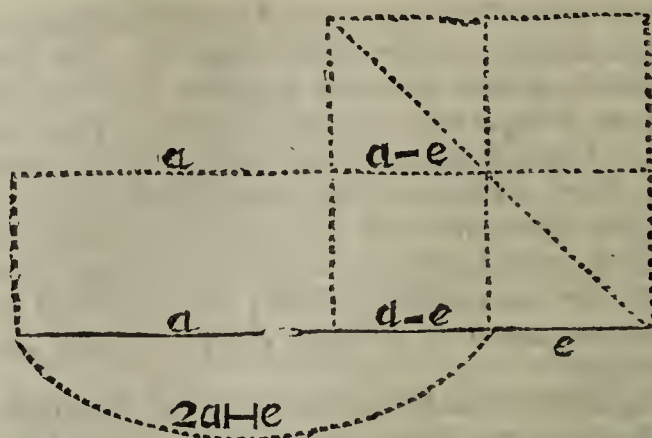
$$\begin{array}{r} a + e \\ a + e \\ \hline aa + ee \\ + ee + ee \\ \hline aa + 2ae + ee \end{array}$$

### COROLLARIES.

Hence 'tis plain, that the Square of any Line is equal to four times the Square of its half. For suppose  $Z$  to be bisected, then each Part will be  $a$ ; and multiplying  $a + a$  by itself, the thing will plainly appear.

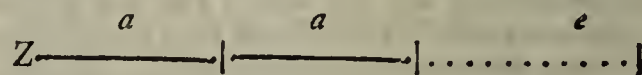


5. If a Line be divided into two Parts equally, and into two other Parts unequally, the Rectangle under the unequal Parts, together with the Square of the intermediate Part, the Difference between the equal and unequal Parts, is equal to the Square of half that Line.



Let the whole Line be  $2a$ , then each Part will be  $a$ ; let the lesser unequal Part be  $e$ , then the greater unequal Part will be  $2a - e$ ; which multiplied by  $e$ , produces  $2ae - ee$ . To which adding the Square of the Difference, or intermediate Part  $a - e$ , which is  $aa - 2ae + ee$ , the Sum will be only  $aa$ , the Square of half the Line.

6. If a Line be bisected, and then another Right Line be added to it, the Rectangle or Product of the whole augmented Line multiplied by the Part added, together with the Square of the half Line, is equal to the Square of the half Line, and part added, as one Line.



Let the first Line be  $2a$ , and the Part added  $e$ , then the whole will be  $2a + e$ ; which multiplied by  $e$ , produces  $2ae + ee$ , and the Square of half the Line  $aa$  being added to it, it will be  $2ae + ee + aa$ , which is equal to the Square of  $a + e$ , by Prop. 4.

7. If a Quantity or Line be divided any how into two Parts, the Square of the whole added to the Square of one of the Parts, shall be equal to two Rectangles contained under the whole Line and that Part, added to the Square of the other Part.



Let  $a$  be one Part, and  $e$  the other; the Square of the whole, and if the lesser Part  $e$ , makes  $aa + 2ae + 2ee$ . Then if the whole  $a + e$  be multiplied twice by  $e$ , it will produce  $2ae + 2ee$ ; and if to this be added the Square of the other Part  $aa$ , the Sum will be

$aa + 2ae + 2ee$ , equal to the former.

8. If a Line cut any how into two Parts, the Quadruple Rectangle under the whole Line and one of the Parts, added to the Square of the other Part, is equal to the Square of the whole, and the other Part added to it, as if it were but one Line.

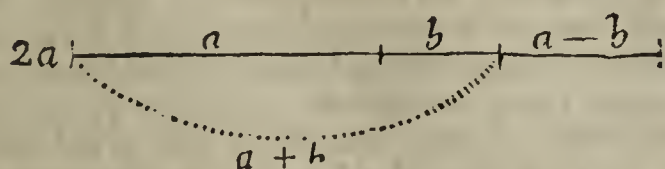


Let the whole Line be  $a + e$ , then four times that multiplied by  $e$  (or the Quadruple Rectangle under that and  $e$ ) will be  $4ae + 4ee$ ; to which adding the Square of the other Part  $aa$ , the Sum will be  $aa + 4ae + 4ee$ .

And if you square  $a + 2e$ , which expresses the whole Line, with  $e$  added to it, the Product will be the former Sum of  $aa + 4ae + 4ee$ .



9. If a Line be bisected, and also cut into two other unequal Parts, the Sum of the Squares of the unequal Parts will be double to the Sum of the Squares of the half Line, and of the Difference between the two unequal Parts.



Let the whole Line be  $2a$ , and the Difference between the equal and unequal Parts  $b$ ; then the greater unequal Part will be  $a+b$ , and the lesser  $a-b$ : The Sum of the Squares of the unequal Parts will be  $2aa + 2bb$ , which is double to the Square of half the Line added to the Square of the Difference. Q. E. D.

10. If a Line be bisected, and then another Line added to it; the Square of the whole increased Line, together with the Square of the Part added, is double the Sum of the Squares of the half Line, and of the half Line and Part added, taken as one Line.



Let the whole Line be  $2a$ , and the Part added  $e$ ; then the whole increased Line will be  $2a+e$ ; and the half Line and Part added, will be  $a+e$ . The Sum of the Squares of  $2a+e$ , and of  $e$ , is  $4aa + 4ae + 2ee$ ; which is plainly double to  $aa$ , and  $aa + 2ae - ee$  added together. Q. E. D.

LINE, in Fortification, is that which is drawn from one Point to another, in delineating a Plane upon Paper: But in the Field it is sometimes taken for a Ditch bordered with its Parapet, and sometimes for a Row of Gabions, or Sacks of Earth, extended in Length on the Ground, to serve as a Shelter against the Enemies Fire. Thus they say, when the Trenches were carried on within thirty Paces of the *Glacis*, we drew two Lines, one on the Right Hand, the other on the Left, for a Place of Arms.

LINE Capital, is that which is drawn from the Angle of the Gorge to the Angle of the Bastion.

LINE Cogritel, is that which is drawn from the Angle of the Center to that of the Bastion.

LINE of Defence, is that which represents the Course of the Bullet of any sort of Fire-Arms, more especially of a Musquet-Ball, according to the Situation which it ought to have to defend the Face of the Bastion.

LINE of Defence Fix'd or Fichant, is that which is drawn from the Angle of the Curtain to the flank'd Angle of the opposite Bastions; nevertheless without touching the Face of the Bastion. This must never exceed 800 Feet, which they reckon the Distance a Musquet-Ball will do Execution.

LINE of Defence Razant, is that which being drawn from a certain Point of its Curtain, raseth the Face of the opposite Bastion. This is called also the Line of Defence Stringent or Flanking.

LINE of Approach, or of Attack, signifies the Work which the Besiegers carry on under Covert, to gain the Moat, and the Body of the Place.

LINE of Circumvallation, is a Line or Trench cut by the Besiegers within Cannon shot of the Place, which rangeth round their Camp, and secures its Quarters against the Relief of the Besieged.

LINE of Contravallation, is a Ditch bordered with a Parapet, which serves to cover the Besiegers on the side of the Place, and to stop the Sallies of the Garrison.

LINES within side, are the Moats towards the Place, to prevent the like Sallies.

LINES without side, are the Moats towards the Field, to hinder Relief.

LINES of Communication, are those that run from one Work to another: But the Line of Communication, more especially so called, is a continued Trench with which a Circumvallation or Contravallation is surrounded, and which maintains a Communication with all its Forts, Redoubts, and Tenables.

LINE of the Base, is a Right Line which joins the Points of the two nearest Bastions.

To LINE a Work, is to strengthen a Rampart with a firm Wall, or to encompass a Parapet or Moat with good Turff, &c.

LINEA Apfidum, or the Line of the Apfès, in the old Astronomy, is a Line passing through the Center of the World, and the Center of the Excentrick; and whose two Ends are, one the Apogee, the other the Perigee of the Planet. That part of this Line which lies between the Center of the World and that of the Excentrick, is called the Excentricity.

LINE of Greatest or Least Longitude of a Planet, is that part of the Linea Apfidum reaching from the Center of the World to the Apogee or Perigee of the Planet. But the

LINE of Mean Longitude, is one drawn through the Center of the World at Right Angles to the Linea Apfidum, and is there a new Diameter of the Excentrick or Deferent; and its extrem Points are called the Mean Longitudes.

LINE of the mean Motion of the Sun, in the old Astronomy, is a Right Line drawn from the Center of the World as far as to the Zodiack of the *Primum Mobile*, and parallel to a Right Line drawn from the Center of the Excentrick to the Center of the Sun; which latter Line they call also the

LINE of the mean Motion of the Sun in the Excentrick, to distinguish it from the former; which is the Line of mean Motion in the Zodiack of the *Primum Mobile*.

LINE of the Sun's true Motion, is a Line drawn from the Center of the World to the Center of the Sun, and produced as far as the Zodiack of the *Primum Mobile*.

LINE Horizontal, is a Right Line parallel to the Horizon.

— In Dialling, it is the common Section of the Horizon and the Dial-Plane.

— In Perspective, it is the common Section of the Horizontal Plane, and that of the Draught or Representation, and which passes through the principal Point.

LINE Geometrical, in Perspective, is a Right Line drawn any how on the Geometrical Plane.

LINE Terrestrial, in Perspective, is a Right Line, wherein the Geometrical Plane, and that of the Picture or Draught intersect one another.

LINE of the Front, in Perspective, is any Right Line parallel to the Terrestrial Line.

LINE Vertical, in Perspective, is the common Section of the Vertical and of the Draught.

LINE of Station, in Perspective, according to some Writers, is the common Section of the Vertical and Geometrical Planes. Others, as Lamy, mean by it the perpendicular Height of the Eye above the Geometrical Plane. Others, a Line drawn on that Plane, and perpendicular to the Line, expressing the Height of the Eye.



LINE *objective*, in Perspective, is the Line of an Object, from whence the Appearance is sought for in the Draught or Picture.

LINE of *Gravitation*, of any heavy Body, is a Line drawn through its Center of Gravity, and according to which it tends downwards.

LINE of *Direction*, of any Body in Motion, is that according to which it moves, or which directs and determines its Motion.

LINE of the *swiftest Descent* of a heavy Body: See the *Cycloid*.

LINE of the *Anomaly* of a Planet, in the Ptolemaick System, a Right Line drawn from the Center of the Excentrick to the Center of the Planet.

LINE of the *Apogee* of a Planet, in the old Astronomy, is a Right Line drawn from the Center of the World, through the Point of the *Apogee*, as far as the Zodiack of the *Primum Mobile*.

LINE of the *Nodes* of a Planet, in the new Astronomy, is a Right Line from the Planet to the Sun, being the common Intersection of the Plane of the Planets Orbit with that of the *Ecliptick*.

LINE *Synodical*, in reference to some Theories of the Moon, is a Right Line supposed to be drawn through the Centers of the Earth and Sun: And if it be produced quite thro' the Orbits, 'tis called the

LINE of the *True Syzygies*. But a Right Line imagined to pass through the Earth's Center, and the mean Place of the Sun, is called the

LINE of the *Mean Syzygies*.

LINE *Horary*, or the *Hour-lines*, in Dialling, are the common Intersections of the Hour-Circles of the Sphere, with the Plane of the Dial.

LINE *Substylar*, is that Line on which the Style or Cock of the Dial is erected, and is the Representation of such an Hour-Circle as is perpendicular to the Plane of that Dial.

LINE *Equinoctial*, in Dialling, is the common Intersection of the Equinoctial, and the Plane of the Dial.

LINE of the *True Place* } of a Planet, is a right  
*Apparent* }  
 Line drawn from { *Earth's Centre*, } thro' the  
                           { *Eye of the Spectator* } Planet, and continued as far as the fixed Stars.

LINE of *Measures*, in the Stereographick Projection of the Sphere in *Plano*, is that Line in which the Plane of a great Circle, perpendicular to the Plane of the Projection, and that oblique Circle which is to be projected, intersects the Plane of the Projection. Or it is the common Section of a Plane passing thro' the Eye Point, and thro' the Centre of the Primitive, and at right Angles, to any oblique Circle which is to be projected, and in which the Centre and Pole of such Circle will be found.

LINE of *Direction*, of the Earth's Axis in the *Pythagorean* System of Astronomy, is the Line connecting the two Poles of the *Ecliptick*, and of the Equator, when they are projected on the Plane of the former.

LINE of the *Section*, in Perspective, is the Intersection or Contact of the Plane to be projected with the *Glass* or *Diaphanous Plane*.

LINE of *Lines*, on the Sector, is a Scale of equal Parts on each Leg, and running from the Centre. This is divided actually into 100 equal Parts, and sometimes into more, when the Instrument is large. There are only the Figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, placed on the Lines; and therefore they sometimes stand for themselves alone, and sometimes signify ten times, or an hundred, or a thousand times themselves, according as the Matter shall require.

## The Uses of the Line of Lines.

1. To increase or diminish a Line of any given Length, according to any Ratio required.

Suppose the Line were  $6\frac{1}{2}$  Inches in Length; apply it unto the Sector by way of parallel Entrance, so that each Foot of the Compasses stand in  $6\frac{1}{2}$  in Line of Lines, and then let the Sector be kept at that Angle. Then if you would have it increased in the Proportion of  $9\frac{3}{4}$  to  $6\frac{1}{2}$ ; or diminished in the Proportion of  $2\frac{3}{4}$  to  $6\frac{1}{2}$ , &c. let the Sector lie, and take with the Compasses the parallel Distances between those Points of  $9\frac{3}{4}$  and  $9\frac{1}{4}$ ; or of  $2\frac{3}{4}$  and  $2\frac{1}{4}$ , in the Line of Lines of each Leg, and that will give you the Length required.

2. To divide a given Line into any Number of Parts; as suppose into 9.

Apply the Line over from 9 to 9 in the Line of Lines; and keeping the Sector of that Angle, take the Distance between 1 and 1, and that will be  $\frac{1}{9}$  Part of the Line.

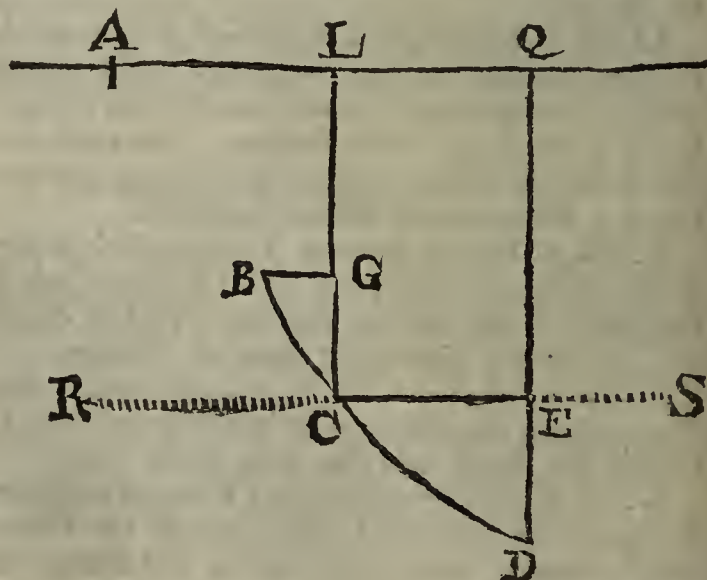
3. To find what Proportion two or more Lines bear to one another.

Apply the greater or greatest over from 10 to 10 at the Ends of Lines; and then taking any of the other, and applying it over parallel to the former, it will mark out such Numbers as shall express its Proportion to the greatest Line: as suppose the Compasses pointed to 30 and 30; then will the greatest Line be to it as 100. is to 30. &c.

4. To work Proportions with the Sector, proceed just as you do in finding a 3d or 4th Proportional to 2 or 3 Lines given geometrically. See *Proportion*.

LINEA *Celerrimi Descensus*, is that Curve which a Body would describe in its Descent, if it moved the swiftest possible: The Investigation of which was first, I think, proposed as a Problem by Mr. John Bernoulli, and hath been solved by his Brother James, and several others; and very easily thus, by Mr. John Craig, in *Phil. Trans.* N<sup>o</sup> 268.

Suppose BC, CD, two infinitely small Parts of the Curve sought: Then, since the Nature of the Curve is to be such, that the Descent of the Body from B to D,





after its Fall from the Horizontal Line A Q, is to be in the least time possible; we must find in the Line R S (drawn parallel to A Q so, that the Differences between any two Ordinates to the Curve, as of G C, D E, may be equal) a Point in which this must happen.

Now the Velocity of the Body in the Point C is  $\sqrt{LC}$ ; and its Velocity in the Point D, as  $\sqrt{QD}$ . Wherefore  $\left(\frac{BC}{\sqrt{LC}}\right)$  is to the Time

of the Descent thro' B C, as  $\frac{CD}{\sqrt{QD}}$  to the Time of the Descent thro' C D, by Prop. 54. Newton's Princ. Wherefore the Point C must be such, as that  $\frac{BC}{\sqrt{LC}} + \frac{CD}{\sqrt{QD}}$  must be a Minimum, or

the least possible. Suppose then the Points B and D to be fix'd; let G C (= D E) =  $m$ : L C =  $b$ , and Q D =  $p$ , all invariable Quantities: and let the flowing Quantities B G =  $u$ : and C E =  $z$ .

Wherefore  $\frac{\sqrt{m^2 + u^2}}{\sqrt{b}} + \frac{\sqrt{m^2 + z^2}}{\sqrt{p}}$  = to a

Minimum. And consequently  $\frac{u}{b^{\frac{1}{2}} \sqrt{m^2 + u^2}} +$

$+\frac{z}{p^{\frac{1}{2}} \sqrt{m^2 + z^2}} = 0$ . But  $\dot{u} = -\dot{z}$  (because  $u + z$  = to an invariable Quantity.) Wherefore

$\frac{u}{b^{\frac{1}{2}} \sqrt{m^2 + u^2}} = \frac{z}{p^{\frac{1}{2}} \sqrt{m^2 + z^2}}$ : Wherefore 'tis

plain that  $\frac{u}{b^{\frac{1}{2}} \sqrt{m^2 + u^2}}$  = to an invariable Quantity. Let then the Abscissa A L =  $x$ ; the Ordinate L C =  $y$ : And therefore B G =  $\dot{x}$ . G C =  $\dot{y}$ . B C =  $\sqrt{\dot{x}\dot{x} + \dot{y}\dot{y}}$ . and let  $a$  be any invariable

Line. Then will  $\frac{\dot{x}}{y^{\frac{1}{2}} \sqrt{\dot{x}\dot{x} + \dot{y}\dot{y}}} = \frac{1}{\sqrt{a}}$ .

Wherefore  $\dot{x} \sqrt{a} = y \times \sqrt{\dot{x}\dot{x} + \dot{y}\dot{y}}$ . But in every Curve  $\dot{x}$  is to  $\sqrt{\dot{x}\dot{x} + \dot{y}\dot{y}}$ , as the Subtangent to the Tangent: Wherefore the Nature of this Curve is such, that the Subtangent is to the Tangent as  $\sqrt{a}$ , is to the  $\sqrt{y}$ . which is known to be the Property of the Cycloid; where the Tangent is parallel to the Chord of a Conterminous Ark in the generating Circle, whose Diameter is  $a$ , and its Vertex downward.

LINES, in the Art of War, signify the Position of an Army ranged in Order of Battel, extending themselves to such a Length, or as far as the Ground will allow, to prevent flanking. Armies do usually place themselves in three Lines: The first of which is the *Van* or *Advanc'd Guards*; the second the *Main Body*; the third the *Rear-Guard*, or *Reserve*. There is left the Distance of about 150 Paces between the two first Lines, and about double that Distance between the second and last. To

LINE Hedges, is to plant Musqueteers all along them under their Covert, to fire upon an Enemy that comes open, or for a Defence against Horse.

LINEA Alba, is a Concourse of the Tendons of the Muscles of the *Abdomen*, excepting the Tendons of the straight ones; for the Tendons of the oblique Muscles unite, and meet so on both Sides, that they make a kind of Tunick that covers the *Abdomen*, as if they were all but one Tendon. It is white, and not fleshy, proceeding from the *Carti-*

*lago Ensisformis* to the Os Pubis; and is narrower below the Navel than above.

LINES of Solids. See Solids.

LINES of Superficies or Surfaces. See Surfaces.

LINES of Chords. See Chords.

LINES of Tangents. See Tangents.

LINES of Secants. See Secants.

LINEAMENT [*Lineamentum*, L.] a fine Stroke or Line observed in the Face, and forming the Delicacy of it; it is that which preserves the Resemblance, and causes the Relation of Likeness or Unlikeness to any other Face.

LINEAR Problem, in Mathematicks, is such an one as can be solved geometrically by the Intersection of two Right Lines; as to measure an inaccessible Height by the means of two unequal Sticks or Staves. This is also called a simple Problem, and is capable but of one Solution.

LINEAR Numbers, are such as have relation to Length only; as (*v. gr.*) such as represent one side of a plane Figure: And if the plane Figure be a Square, the Linear Number is called a Root.

LINES of Chords, Sines, Tangents, Secants, Versed Sines, &c. See Scale.

LINED Moat, a Term in Fortification: See Moat.

LINGOT, the Term in Chymistry for the *Molds* they make to cast melted Metals, or the *Regulus of Antimony*, &c. into.

LINGUA, the Tongue, is an oblong, broad, thick Member, and thicker at the Root, and thinner and sharper at the End; of a moderate Bigness, that it may move more quickly. In the exterior or upper Part of the Tongue there are a great many little Bodies, which break out from the Surface of the Tongue, and bending a little, incline backwards towards the Root, so that they look like a Comb to card Wool. These Cartilaginous Bodies, in an Ox especially, seem to resemble the Figure of a Boar's Tooth. In the lower Part they have a certain Cavity. They are made of a thick tenacious fibrous Matter, which seems like a Heap of little Rods: About the Sides of the Tongue they grow smaller and smaller, so that they almost disappear; and certain Membranous Bodies are placed at their Basis, which appear at first of a Conical Figure, and then by and by of a more obtuse one, and of a pappy Substance. All the little Protuberances are cloathed with the Membranes of the Tongue: They are firmly implanted in a certain tenacious Tunick of the Tongue, there being under them a crass, viscous or nervous Substance, especially in those Places where there are remarkable Pits in the Tongue disposed in like Order and Manner; so that in the inner Part of the Tongue there are a great many of them, which are firmly implanted in a kind of viscous Body. When the Membrane that covers the whole Tongue is taken off, there appears a certain glutinous Substance; then a nervous pappy Body, something Yellow, which spreads like the Membrane, and discovers several remarkable nervous Protuberances, dispos'd and order'd in a wonderful Order. The next Things that appear are like Nipples, in greater abundance than those before-mentioned, and of another Order; for as many little Protuberances as cover the Outside of the Tongue, so many nervous Nipples of this sort are found within. These proceed from the common pappy Substance, grow tolerably high, and shoot out further into nervous Sprouts from the Top of them; about which you discover innumerable little Protuberances proceeding from the Stock, and of an equal Height, only slenderer, like a Cone, and which



which go within their proper Cavities, ready made in the crass viscous Substance before-mentioned, and at last end toward the outermost Membrane. Farthermore, the Substance of the Tongue is muscular: The Central Parts of the Tongue consist of several sorts of Fibres, long, transverse and oblique, which being mutually interwoven with one another, look like a Coverlid or Blanket. It owes its Motion to peculiar Muscles of its own, where-with it is contracted and abbreviated. The Pairs of Muscles are the *Styloglossum*, *Basoglossum*, *Genioglossum*, *Ceratoglossum* and *Myloglossum*: which see. *Blanchard*.

LINGUALIS, is taken by some to be a large and fleshy Muscle arising from the Basis of the Os *Hyoides*, and runs forward to the Tip of the Tongue; and *Spigelius* gives it this Use, That its transverse Fibres do thicken, and as it were constringe the Tongue, and dilate it by its oblique Fibres, and bring it towards the Palate by its right Fibres: But it is disputable whether it be a *Muscle* or not.

LINIMENT [in *Pharmacy*] a Medicine for softening the Asperities of the Skin, and moistening those Parts that are to be softened, in order to resolve the Humours that afflict the Patient, and cause Pain.

LINTEL [in *Carpentry*] that Piece of Timber that lies horizontally over the Door-Posts and Window-Jaumbs, as well to bear the Thickness of the Wall over it, as to bind the Sides of the Wall together.

LINSTOCK, is a short Staff of Wood about three Foot long, having at one End a piece of Iron divided into two Branches, each of which hath a Notch to hold a piece of Match, and a Screw to fasten it there. The other End of the Staff is shod also with Iron, and pointed to stick into the Ground. 'Tis used by the Gunners in firing Cannon.

LINTER: See *Scapha*.

LINUM *Vivum*: See *Asbestine Cloth*.

LIONCELS, the Herald's Term for *Lions*, when there is more than two of them born in any Coat of Arms, and no Ordinary between them; and 'tis all one as a small or young Lion.

LIPOTHYMIA, [*λειποθυμία* of *λείπω* to leave, *θύμος*, Gr. the Mind] or *Lipopsychia*, is a swooning or fainting away, being an imperfect *Syncope*; which see.

LIPPITUDE [*Lippitudo*, L.] a Disorder of the Eyes, otherwise called *Blear-eyedness*; which consists in the oozing out of a thick viscous Humour, which hardens and binds the Eyelids together.

LIPS are the Edge or exterior Part of the Mouth, or that muscular Extremity which shuts and covers the Mouth both above and below. The Lips, besides the common Integuments, consist of two Parts, the exterior hard and muscular, the interior soft, spongy and glandulous, covered with a fine Membrane; the fore and protuberant Parts of which are red, and call'd *Prolabia*. The Lips have six Pair of Muscles belonging to them, and one odd one; of these three are peculiar to the upper and under Lip, the other three and the single one are common to both Lips. The peculiar are the *Attollens labiorum superius*, *Deprimens labiorum inferius*, *Attollens labiorum inferius*. The three common Pair are the *Zygomaticus*, the *Attollens labiorum*, the *Depressor labiorum*; the odd one *Orbicularis*.

LIQUEFACTION, an Operation by which a solid Body is reduc'd into a Liquid, or the Action of Fire or Heat on fat fusible Bodies, which puts their Parts into Motion.

LIQUID, is a Word used by the Civilians in this Sense, for a Thing's being apparently proved, as they say: A Creditor would be injur'd, should a Debt which is clearly due be stopp'd, on the Pretence of another Debt that is not *Liquid*, or apparently proved.

LIQUIDUM *Nervorum*, is that Juice or Fluid which Nerves carry in their Canals, and is usually called the *Nervous Juice*.

LIQUIDS, are such Bodies as have all the Properties of *Fluidity* (see that Word); and withal, have their Particles so formed, figured or disposed, that they do adhere to the Surfaces of such Bodies as are immersed in them, which we call *wetting*: And this Property of Liquid Bodies is sometimes called *Humidity* or *Moisture*.

LIQUIDS [in *Grammar*] certain Consonants that are opposed to Mutes, as L, M, N and R.

LIQUOR of *Fix'd Nitre*: See *Fix'd Nitre*.

LIST, in Architecture, is a straight upright Ring, which runs round the lower Part of any of the Columns just above the *Tore*, and next to the Shaft or Body of the Pillar.

LISTEL, a small Band, or a kind of a Rule in the Mouldings of Architecture: Also the Space between the Channellings of Pillars.

LITERAL *Algebra*: See *Algebra*.

LITHARGE, what, and how made; see *Purification of Silver*.

LITHIASIS, [*λιθίασις*, Gr.] the Breeding of the Stone in the Kidneys or Bladder.

LITHONTRIPTICKS, [*λιθοντριπτικά*, of *λίθος* a Stone, and *τρίβω*, Gr. to break] are Medicines which break the Stone, either in the Bladder or the Kidneys.

LITHOTOMIA, [*λιθοτομία*, of *λίθος* and *τέμνω*, Gr. to cut] is the grand Operation of cutting the Stone out of the Bladder; and is thus described by *Blanchard*. The Operator lays the sick Person upon a soft Pillow, in the Bosom or Lap of some strong Man, after he has leap'd three or four times from on high; then he ties the Hands on each side fast to the Sole of the Foot, and two People standing on each side hold the Knees as open as possible. After this, the Operator moistening one Finger of his Left-Hand, or if Necessity require the two foremost, with Oyl of White Roses, thrusts them up into the Fundament, and with his Right-Hand presses the Upper Parts of the Secrets lightly, that by this means the Stone may be brought to the *Perinæum*; which when he has forced thither with his Fingers, he cuts with a two-edged Knife, proportionably to the Bigness of the Stone, in the Left Side, betwixt the Testicles and the Fundament, near to the Suture of the *Perinæum*, bringing the Stone towards the Knife: And if the Stone come not out, either of its own accord, or by thrusting of the Fingers, he draws it out with the *Forceps*; i. e. a pair of Pincers, or some such Instrument of Art. The Stone being drawn out, and all the Bands being loosed, he closes the Wound duly, applies Remedies, stops the Blood, and takes care that the Wound be closed up, lest the Urine should continually drop through. This Way is called *Apparatus minor*, and is used especially in Boys, though it be frequently practised too in adult Persons in these Countries. This we in England call *Cutting upon the Gripe*, and is the Method that our Suters always cut by: But in the *Apparatus major*, or the greater Operation, which we call *Cutting upon the Staff*, the Patient, bound as before, is set upon a Table, and held there; then the Chyrurgeon thrusts in his Instrument, called *Itine-*  
*rarium*,



*varium*, by the Urinary Passage into the Bladder, as far as the very Stone; and cutting an Hole, as before, he puts another Instrument, called *Conduktor*, into the hollow Part of the *Itinerarium*, thro' the Wound; then the *Itinerarium* being taken out of the Urinary Passage, he puts in the Instrument called *Forceps* (a sort of Pincers) or any other fit to pull out the Stone through the Wound before made, that he may lay hold of the Stone, and bring it out: This being done, the Wound is bound up, and consolidated, as 'tis in Children; only if it be large, it is stitched up, and an Instrument of Silver applied to it for two or three Days, which is useful to let out concremented Blood, Phlegm, and gravely Urine. There is yet another Way of taking out the Stone, to wit, By making a Hole in the *Abdomen*, by which the Stone is taken out of the Bottom of the Bladder; and in this way no dribbling of Urine need to be feared. *Blanchard*.

**LITHOTOMIST**, is a Chirurgion who is skillful in cutting the Stone out of the Bladder.

**LITOTES**, or *Diminutio*, is a Trope in Rhetorick, by which we speak less than we think: As when we say, *I cannot commend you*; it implies a secret Reprehension for something committed that hinders us.

**LITTORAL Shells**, are with the Writers of Natural History, such Sea-shells as are always found near the Shores, and never far off in the Deep: But such as are found there in the Bottom of the Sea, remote from the Shore, they call *Ἐμπεδθιοι* and *Pelagiae*.

**LIVER**. See *Hepar*.

**LIVER of Antimony**: See *Crocus Metallorum*.

**LIVERY** hath three Significations: In one it is used for a Suit of Cloth or Stuff that a Gentleman giveth in Coats, Cloaks, Hats, or Gowns, with Cognisance, or without, to his Servants or Followers. In the other, it signifies a Delivery of Possession to those Tenants which held of the King in *Capite*, or Knight's Service; for the King, by his Prerogative, hath *primer Seisin* of all Lands and Tenements so holden of him. In the third Signification, *Livery* is the Writ which lies for the Heir to obtain the Possession of Seisin of his Land at the King's Hands.

**LIVERY of Seisin**, is a Delivery of Possession of Lands or Tenements, or rather Things corporeal, unto one that hath Right, or a Probability of Right to them. This is a Ceremony in the Common Law, used in Conveyance of Lands or Tenements, &c. where an Estate in Fee-simple, Fee-tail, or a Free-hold, shall pass; and is a Testimonial of the willing departing of him who makes the *Livery*, from the Thing whereof *Livery* is made; and the receiving of the *Livery* is a willing Acceptance of the other Party. And it was invented, that the Common People might have Knowledge of the Passing or Alteration of Estates from Man to Man, that thereby they might be the better able to try in whom the Right of Possession of Lands and Tenements were, if they should be impanelled in Juries, or otherwise have to do concerning the same. Of this *Livery* there be two kinds, *viz.* a *Livery in Deed*, and a *Livery in Law*: A *Livery in Deed*, is when the Feoffor taketh the Ring of the Door, or Turf or Twig of the Land, and delivereth the same to the Feoffee in the Name of the *Seisin* of the Land. A *Livery in Law*, is when the Feoffor saith to the Feoffee, being in View of the House or Land, *I give to you yonder Land, to you and your Heirs; and therefore enter into the same, and take Possession thereof accordingly*: And

the Feoffee doth accordingly, in the Life of the Feoffor, enter: This is a good Feoffment.

**LIVIDUS**: See *Pectineus*.

**LIXIVIOUS**, or *Lixivate Salts*, are the fix'd Salts of Plants, &c. They are drawn by *Calcination* of the Plant, and then making a Lye or Lixivium of the Ashes and Water; whence this Name. See *Salts*.

Mr. Boyle saith, The distinguishing Mark of *Lixivious Salts*, whereby they differ from Urinous ones, is, That they will turn a Solution of Sublimate in Common Water, into a Yellow Colour: See *Experiments on Colours*.

**LIZIERE**, a Term in Fortification; the same with *Berme*; which see.

**LOAD**, is the Miners Word, especially in the Tin Mines, for a Vein of Ore.

**LOADSTONE**: See *Magnet*.

**LOBE**, a Word used mostly by Anatomists for the Division of the Lungs into several Parts, which they call *Lobes*: And by Botanists, for the Division or Parts of the Bulk of Seeds, which usually consist of two Parts or *Lobes*; as is very conspicuous in Beans.

**LOBUS Auris**, is the lower Part or Tip of the Ear.

**LOCAL**, is whatever is supposed to be tied or annexed to any particular Place: Thus in *Law*, they say the Thing is *Local*, and annexed to the Free-hold.

And an Action of Trespass for Battery, &c. is transitory, not *Local*; that is, it is not needful that the Place where the Battery was committed should be set down as material in the Declaration; or if it be set down, the Defendant cannot traverse it, by saying he did not commit the Battery in the Place mentioned in the Declaration, and so avoid the Action.

**LOCAL Colours**, in Painting, are such as are natural and proper for each particular Object in a Picture; and they are so called to distinguish them from the *Claro-Obscuro*: which see.

**LOCAL Medicaments**, are those which are applied outwardly, as Plaisters, Ointments, Salves, &c. These are also frequently called *Topicks*.

**LOCAL Problem**, in Mathematicks, is such an one as is capable of an infinite Number of different Solutions: so that the Point which is to resolve the Problem, may be indifferently taken within a certain Extent; as suppose any where in such a Line, within such a Plane Figure, &c. which is called a *Geometrick Place*, and the Problem is said to be a *Local* or *Indetermined* one. And this *Local Problem* may be either *Simple*, when the Point sought is in a Right Line; *Plane*, when the Point sought is in the Circumference of a Circle; *Solid*, when the Point required is in the Circumference of a Conick Section; or, lastly, *Surfsolid*, when the Point is in the Perimeter of a Line of the *second Gender*, as the Geometers call it.

**LOCATIO-Conductio**, in the Civil Law, is a Contract of the Law of Nations, whereby the Use of a Thing, or the Service and Labour of a Person, is gained for some Time for a certain Reward.

**LOCH**, or *Loboch*, the same with *Eclegma*.

**LOCHIA**, are the natural Evacuations of Women in Child-bed, after the Birth of the *Fetus*, and the Exclusion of the Membranes called *Secundinae*, or the After-birth.

**LOCKER**, in a Ship, is a kind of Box or Chest made along the side of a Ship, to put or stow any thing in.



LOCKING-WHEEL, see *Count-Wheel*, a Term in Watch-work.

LOCK-SPIT, a Term in Fortification, signifying the small Cut or Trench made with a Spade, to mark out the first Lines of any Work that is to be made.

LOCULAMENTUM, in Botanicks, is a little distinct Cell or Partition within the common *Cap-sula seminalis* of any Plant; as those within the Seeds of Poppies, &c. by which one Parcel of the Seeds is kept distinct from another.

LOCUS, or the Place of any Body, is rightly, by Mr. Newton, distinguished into *Absolute* and *Relative*: And so ought Space to be accounted; for the

LOCUS *Absolutus*, or *Primarius* of any Body, is that Part of the absolute and immovable Space, or extended Capacity, to receive all Bodies which this individual one takes up: But the

LOCUS *Relativus*, or *Secundarius*, is that apparent and sensible Place in which a Body is determined to be placed in by ourselves, and with relation to other adjoining or contiguous Bodies.

LOCUS *Apparens*, a Term in Opticks: See *Apparent Place of any Object*. 'Tis also in Astronomy, that Place in which any Planet or Star appears, when viewed from an Eye at the sensible Horizon.

LOCUS *Resolutus*, according to Pappus's Account of it in *Libr. 7<sup>mo</sup> Mathem. Coll.* is, That it is a proper peculiar Matter, after the common Constitution of the Elements of Geometry, contrived for such Persons as would obtain a ready and easy Method of solving such Problems as shall be proposed to them. (See *Resolution*) On this Subject Euclid, Apollonius Pergæus, Eratosthenes and Aristæus Senior, are the only Writers among the ancient Geometers. Euclid's Tracts are *Datorum Liber Unus*; *Locorum ad Superficiem Duo*; *Porismatum Tres*. Apollonius, *de Sectione Rationis* (lately put out at Oxon by Mr. Halley) *Libri Duo*: *De Sectione Spatii Libri Duo*; *Tactionum Libri Duo*: *Inclinationum Duo*; *Planorum Locorum Duo*: *Conicorum Octo*. Of Aristæus, there were *Locorum Solidorum Libri Quinque*. And of Eratosthenes, *Duo Libri de Medietatibus*.

There are two Kinds, saith Pappus, of this *Resolution*; one, where bare Truth in Theory only is pursued; which therefore he calls the *Contemplative Method or Theoretic*: and the other, where we investigate something which we propose to have done; and this is called the *Problematic Method*. What this *Resolution* or *Analysis* of the Ancients was, you may see in the learned Mr. Halley's Edition of *Apollonius de Sectione Rationis* above-mentioned; and a good Attempt towards its Restitution in a modern Spanish Author, Hugo de Omerique, his *Analysis Geometrica*, printed at Calés 1698.

LOCUSTÆ are the Beards and pendulous Seeds of Oats, and of the *Gramina paniculata*; to which the Botanists gave this Name from their Figure, which something resembles that of a Locust.

LODEMANAGE, was anciently the Term for the Hire of a Pilot, when he conducted a Ship from Place to Place.

LODE-SHIP, was formerly the Name of a small Fishing-Vessel. *Vid. 31 E. 3. Stat. 3. c. 2.*

LODGMENT, in Military Affairs, is sometimes an Incampment made by an Army; or oftner, it is a Retrenchment dug for a Covert or Shelter, when the Counterscarp, or some other Post is gained. It is also taken for the Place wherethe Soldiers quar-

ter among the Burghers, either in Huts, Baracks, or Tents.

LODGMENT of an Attack, is a Work cast up by the Besiegers, during their Approaches in a dangerous Post, where it is absolutely necessary to secure themselves against the Enemy's Fire; as in a *Covert-way*, in a *Breach*, in the Bottom of the Moat, or elsewhere. This Lodgment consists of all the Materials that are capable to make Resistance, viz. Barrels and Gabions of Earth, Pallisadoes, Woolpacks, Mantelets, Faggots, &c.

LOG, and Log-line: The Log aboard a Ship, is a Piece of Board or Wood about 7 or 8 Inches long, of a Triangular Figure, and with as much Lead cast into it at one End, as will serve to make it swim upright in the Water; at the other End of which is fasten'd a small long Line, called The

LOG-LINE; which is wound about a Reel for that Purpose, fix'd in the Gallery of the Ship. This Line, for about 10 Fathom from the Log, hath, or ought to have, no Knots or Divisions; because so much should be allowed for the Log's being clear out of the Eddy of the Ship's Wake before they turn up the Glass: But then the Knots or Divisions begin, and ought to be at least 50 Foot from one another; tho' the common erroneous Practice at Sea, is to have them but at 7 Fathom, or 42 Foot Distance.

The Use of this Log and Line is to keep an Account, and make an Estimate of the Ship's Way; for as many Knots as run out in half a Minute of Time (which they measure by a Half-minute Glass) so many Miles do they account the Ship to sail in an Hour; or so many Leagues and Miles doth she run in a Watch: as, if there be veered out 4 Knots in half a Minute, the Ship runs 4 Miles an Hour, or 5 Leagues and 1 Mile in a Watch.

The Practice of heaving the Log, is first to let it down into the Water, and then to let it run away so far, as to be out of the Eddy of the Ship's Wake; and then one having an Half-minute Glass in his Hand, turns it up just when the first Knot runs off the Reel (tho' some turn up the Glass just when the Log touchesthe Water) and then the Line running easily off, when the Glass is out, he cries, *Stop!* The other stops the Reel; and then they count the Knots run out, and if they can be so exact, as to account the odd Feet, which the Line shall run out above any Knot, they ought to account 5 Feet for a Tenth part of a Mile more: And thus, if 3 Knots 45 Feet run out in an half Minute, the Ship goes at the rate of 3 Miles 9 Tenths in an Hour.

Now tho' this at best be but a precarious way, 'tis however the most exact of any in use, and much better than that of the Spaniards and Portuguese, who guess at the Ship's Way by the running of the Froth or Water by the Ship's side; or than that of the Dutch, who use to heave over a Chip into the Sea, and so to number how many Paces they can walk on the Deck, while the Chip swims or passes between any two Marks or Bolt-heads on the side. And the Ground and Reason of this Practice of keeping an Account of a Ship's sailing by the Log, is this:

1. That 5 of our English Feet make a Pace, and 1000 of such Paces a Mile, and 60 of such Miles a Degree, and consequently a Degree would contain 300000 Feet. But this is erroneous on all Accounts; for there are both 1006 Paces in a Mile, and 72 such Miles in a Degree.

2. But then this hath been corrected by Mr. Norwood, in his *Seaman's Practice*; who, by most exactly measuring the Distance of two Places under the same Meridian, and finding also the Latitudes of



of those two Places by most accurate Instruments and Observations, he found, That to a Degree of a Great Circle on the Earth there must be 367200 *English* Feet: And this hath been in a good measure confirmed by the *French* Observations and Measurements, who found a Degree to contain 365184 Feet. And yet Mr. *Norwood* considering that the Ships Way is really more than what is found by the *Log*, and also knowing that 'tis better and safer to have the Reckoning to be something before the Ship, and probably also because 'tis a round Number, cast away the 7200 odd Feet, and suppose a Degree to contain just 360000 Feet. Then will a Minute of a Degree contain 6000 such Feet; and that is to be reckoned for the true *Sea Mile*, 60 of which make a Degree: And since 5280 Feet are a Statute Mile, there will be 68  $\frac{4}{11}$  such Miles in a Degree; and of the *Italian* Miles, of 5000 Feet, 72, or 24 Leagues in a Degree. And after this way of accounting, the whole Circumference of our Globe will be 8640 Leagues, or 25920 Miles; which is 120 Leagues, or 360 Miles less than the *French* make it: And yet this is probably less than the Truth, and in Fact less than Mr. *Norwood's* Account.

Now to apply all this to the Estimation of a Ship's Way by the *Log*: If it be considered that an half Minute is the 120th part of an Hour, 'tis plain the Distance between Knot and Knot in the *Log line*, must be also the 120th part of a Minute of a Degree of a great Circle on the Earth; or 120th part of a true Sea Mile or Minute, which is before shewed to contain 6000 Feet: And therefore the Distance between the Knots must be 50 Foot; (for 50 multiplied by 120, produces 6000) because as 30 Seconds is to an Hour, or 3600 Seconds is to a Day; so is 50 Feet to 6000 Feet. Wherefore as many times 50 Feet as a Ship sails in half a Minute, so many Miles must she go in an Hour, supposing her to keep on at the same Rate. To try which, in long Voyages to the *East-Indies*, &c. the *Log* is heaved every Hour; but in shorter Voyages they content themselves with doing it but every two Hours; tho' always the oftner 'tis done, the better.

And from hence plainly appears the gross Error of having but 42 Feet or 7 Fathom between Knot and Knot, which is the common Division of the *Log-line* at Sea. Indeed, being sensible their Divisions are too short, they lessen their Half-minute Glass proportionably, as having that made of only 24 or 25 Seconds. But this is nothing but correcting one Blunder or Error by another; and shews plainly that the Common Sailors will not go out of their way, tho' they are sure they are in the wrong.

Commonly in the Steerage, or some such convenient Part of the Ship, hangs up a Board called the LOG-BOARD; which is a Table divided into Five Columns, and ought to be of the following Form, or one like it.

This *Log-Board's* Account ought daily at Noon (when if possible, let there be an Observation of the Latitude) to be entred into the *Log-Book* or *Traverse-Book*, ruled and columned just as the *Log-Board* is; from whence it may be transcribed into the Journals, and how much way the Ship hath gained in her Course, estimated daily.

To measure whether the Half-minute Glass be true, or to make one upon Occasion, when you can get ashore, you may use this Method:

Fasten a moderately heavy Plummets or Weight at the End of a small String, which hang up against a Wall by a small Pin or Wire, &c. and let its Length from the Pin where it hangs, to the Center of the Plummets or Weight, be just 39 Inches  $\frac{1}{2}$ . Then draw by the Lines hanging still, a Perpendi-

cular on the Wall behind, with a Pencil or some such thing: And taking the Plummets in your Hand, move the Pendulum from the Perpendicular either way 6 or 7 Inches, and then let it swing freely by

Hour of the Day.	Ships Course.	Log-lines run		Winds, Weather, Accidents, &c.
		Knots	Feet.	
1	S. W. b. S.	4	5	W. N. W. a moderate Gale.
2				
3				
4				
5				
6	S.	8	5	W. S. W. a strong Gale.
7				
8				
9				
10				
11	N. W. b. N. $\frac{1}{2}$ W.	7	0	W. b. S. Thick (hazy Weather)
12				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

the Wall; after which take your Half-minute Glass, and turn it up just when you see the String come right against the Perpendicular on the Wall, and then count the Swings of the Pendulum from its passing by the Perpendicular; and if your Glass is out, just when it hath made 30 Swings, it is right, else not; for this Pendulum swings exactly Seconds.

LOGARITHMS, [*λογαριθμος* of *λογος* a Word, and *αριθμος* Number] which Captain *Halley* very well defines to be the Indexes of the Ratio's of Numbers one to another, were first invented by my Lord *Neper*, a Scotch Baron; and afterwards completed by Mr. *Henry Briggs*, Savilian Professor of Geometry at Oxford.

1. *Logarithms* are a Series of Artificial Numbers (invented for the Ease and Expedition of Calculation) proceeding in an Arithmetical Proportion, as the Numbers they answer to do in a Geometrical one: As for Example,

1, 2, 4, 8, 16, 32, 64, 128, 256, are Numbers proceeding from Unity, in a Geometrical Proportion continued. Now if over these you place a Series of Numbers (beginning with 0) in an Arithmetical Proportion, they will stand thus:

0 1 2 3 4 5 6 7 8 9  
1. 2. 4. 8. 16. 32. 64. 128. 256. 512, &c.

And the Numbers above, beginning with (0), and Arithmetically Proportional, are called *Logarithms*.

2. The Addition and Subtraction of *Logarithms* answers to the Multiplication and Division of the Numbers they answer to. Thus the *Logarithm* 2 added to 4, makes the *Logarithm* of 6, whose corresponding Number is 64, (the Product of the Number 4 multiplied into 16). Also the *Logarithm* 5 subtracted



subtracted from 9, leaves the *Logarithm* of 4, whose Number is 16, (equal to 512 divided by 32).

And the Case would be the same if any other Rank of Numbers in an Arithmetical Proportion were made to answer to the Numbers below. And therefore there may be many sorts of *Logarithms*, as indeed there are.

And thus also will Extraction of Roots be performed by bisecting the *Logarithms* of any Numbers for the Square Root, and trisecting them for the Cube: As for Instance,

To extract the Square Root of 256, divide its *Logarithm* 8 by 2, and it will quote 4; which *Logarithmick* Number 4, hath for its absolute Number 16, and therefore 16 is the Square Root of 256.

To extract the Cube Root of 64, divide its *Logarithm* 6 by 3, and the Quote will be 2, which is the *Logarithm* of 4, the Cube Root of 64.

3. To apply this Matter for the making of a Canon or Table of *Logarithms*, that should answer to Common Numbers in their natural Order, the Inventers proceeded in this Method:

They pitched on those which are naturally geometrically proportional; as

1, 10, 100, 1000, 10000, 100000, 1000000, 10000000, 100000000, &c.

And to these they fitted not the single *Logarithms*, 0, 1, 2, 3, &c. as in our Instance, Numb. 1. above, but those augmented with many Cyphers, in order to fit proper *Logarithms* for all intermediate Numbers between 1 and 10, 10 and 100, 100 and 1000, &c. They made therefore 0000000 to be the *Logarithm* of 1, and 10000000 to be the *Logarithm* of 10; also 20000000 they put for the *Logarithm* of 100, and 30000000 for the *Logarithm* of 1000, making still the *Index* or *Characteristick* of the *Logarithm* to be one less than the Number of Places in the Absolute Number, because they appointed 0000000 as the *Logarithm* of 1.

5. But then the greatest Difficulty and Pains was yet to come, which was to find *Logarithms* for all the intermediate Numbers corresponding with those appointed for 1, 10, 100, 10000, &c. which with most indefatigable Pains and Care they thus effected. In order (e.g.) to get the *Logarithm* of 9, they found a middle Proportional between the Absolute Numbers 1 and 10, increased with seven Cyphers each: Then that Number not being exactly the Absolute Number 9, but bigger or lesser than 9, (with seven Cyphers added to it) they accordingly found out new geometrical mean Proportionals between that Number and 10, if it were less; and between that and the next less than it, as soon as it came to be bigger, &c. till at last, after a prodigious Number of Trials, viz. 25. they came to the Absolute Number 8, 9999998, which approacheth very near to 9, 0000000. And in order to find the *Logarithm* of this Number 8, 9999998, they found 21. Arithmetical mean Proportional between the *Logarithm* of 0 and 10 (i.e. between 0000000 and 10000000), and then another between that so found, and 10000000 again; and so on, till at last they came to 0, 9542450. the exact *Logarithm* of 9.

They were forced to proceed after the same manner also to gain the *Logarithm* of 5; but then their Work grew something easier, and more expeditious.

1. For since by dividing 10 by 5, the Quotient is 2, therefore the *Logarithm* of 5, subtracted from the *Logarithm* of 10, must give the *Logarithm* of 2.

2. And as 10, multiplied by 2, gives 20; there-

fore the *Logarithm* of 9 being divided by 2, or halved, must give the *Logarithm* of 3.

3. Since the Square Root of 9 is 3; therefore the *Logarithm* of 9 being divided by 2, or halved, must give the *Logarithm* of 3.

4. By subtracting the *Logarithm* of any one known Number, from that of another, you have the *Logarithm* of the Quotient of the former Number dividing the latter.

And after this or the like manner they proceeded till they had completed the Canon of *Logarithms* to Numbers reaching to 10000.

If you would see an easy and expeditious Way of making several Sorts of *Logarithms* to a large Radius, consult Captain Edmund Halley's *Discourse in Phil. Transf.* N<sup>o</sup> 216. where, from the pure Consideration of Numbers, and withal by the Help of Sir Isaac Newton's Method of finding the *Unciæ* of the Numbers of a Binominal Power, he shews how to find readily the *Logarithms* of all Numbers to above 30 Places; and he gives there several *Series* for this Purpose; some universal, and some appropriated to peculiar Sorts of *Logarithms*.

Nicholas Mercator also did a good while since make some Improvements in this Affair, of which you have Dr. Wallis's Thoughts in *Philosop. Transf.* N<sup>o</sup> 38.

And John Gregory hath also shew'd a way to make *Logarithms* to 25 Places, by means of the *Hyperbola*.

For the *Characteristick* of a *Logarithm*, see in *Index*.

## The Use of the Table of *Logarithms*.

### 1. To find a *Logarithm*.

N. B. I here describe only the common Canon of *Logarithms* contrived by Mr. Briggs, and published in Sir Jonas Moore's *Mathematicks*, and in most Books of *Trigonometry*, *Naviga-tion*, &c.

1. If the Number, whose *Logarithm* you would find, be under 100, you have it always in the first Page: Thus the *Logarithm* of 55 is 1.740363.

2. If the Number consists of three Places, that is, a Number under 1000, look for it in the Table under N, and the *Logarithm* is found in the Column under 0. Thus the *Logarithm* of 216 is 2.334454.

3. If the Number be of four Places, and under 10000, seek the three first Figures under N, as before, and the last Figure on the Top; under which, in that Column lineally against the first three Figures, you have the *Logarithm* required: Thus the *Logarithm* of 3583 is 3.554247, find 358 under N, against which, in the Column under 3, stands your *Logarithm*.

4. If the Number be above 10000, and under 100000, you must find it by the *Difference* and Table of Parts Proportional: Thus, if the *Logarithm* of 35786 be required, first seek the *Logarithm* of the former four Figures 3578, which will be 3.553649; and the common Difference under D is 121. With this Difference enter the Table of Parts proportional, and find 121 in the first Column under 3: and then lineally against that Number, and under 6, the last Figure of the Number 35786, found at the Head of the seventh Column, you will find 72; which being added to the *Logarithm* of 3578, viz. 553649, makes 4 553721, the *Logarithm* of 35786; and the Index must be 4, because the absolute Number consists of five Places.

5. If



5. If the Number be above 100000, and under 1000000, as suppose 357865; then find (as before) the *Logarithm* of the first five Figures, viz. 35786, and 'twill be found to be (omitting the Characteristick 4) 553721: After this, multiply the remaining Figure (5) of the given Number, by the common Difference 70, (found under *D*.) and it will produce 350; then cut off (0) the last Figure of the Product, and add the remaining (35) to the *Logarithm* 553721 aforesaid, the Sum is 553756; to which prefix the proper Characteristick (5) because the Number given hath six Places, and 5.553756 is the *Logarithm* required for 357865.

If the Number be above 1000000, and under 10000000, find the *Logarithm* of the first five Figures (as before) and multiply the common Difference by the two remaining Figures; from which Product cut off the two last Figures, and add the other (as before) prefixing 6 for a Characteristick, &c.

7. And so for any other greater Number proportionably; only be sure to cut off from the Sum so many Figures as you multiply the common Difference by; and add the Remainder to the *Logarithm*, and prefix the Characteristick proper, that is, a Figure of one Place less than the absolute Number, whose *Logarithm* is required.

## 2. Next I will shew the Way of finding the Number answering to a Logarithm given.

Omitting the Characteristick; seek in the Table for that *Logarithm*, which is equal or next less to the *Logarithm* given, the absolute Number in the Column under *N*, with that on the Top over the *Logarithm*, is the Number desired, which must be ordered according to the Characteristick.

Thus, to find what Number answers to the *Logarithm* 3.544821; omitting the Index 3, I find 544821 to answer to 3506, which the Index 3 shews to be all Integers; but if the Index had been 1, then the Number would have been 35.06; that is, 35 Integers and .06 hundred Parts.

But if the *Logarithm* be not exactly to be found in the Tables, and five Places be required, find the Number to four Places (as before) noting the common Difference under *D*, then take the Difference betwixt the *Logarithm* given, and the *Logarithm* found in the Table less than it; seek the common Difference in the Table of proportional Parts under *D*, and in that Line find out the Difference of the *Logarithms*, and at the Top just about it you have the fifth Figure: Thus, if the *Logarithm* required had been 2.543612, the *Logarithm* next less is 543571, answering to 3496; the common Difference is 124, the Difference of the *Logarithms* is 41, which, in the Table of Proportional Parts against 124, gives 3; so that the Absolute Number is 34963: And because the Index is 2, the Number will be 349 Integers, and  $\frac{3}{100}$  Parts, or 349.63.

To find the Number of a Logarithm, whose Index is 5 or more.

Suppose 4 to be the Characteristick, and find (by the foregoing Directions) the *Logarithm* as near as you can (so it be but less); then subtract this *Logarithm* from the *Logarithm* given; and to the Right Hand of the Remainder, if the Index be 5, set 0; if the Index be 6, set 00; if 7, set 000; and so on proportionally. This done, divide the Sum by the common Difference, and the Quote gives the Figure or Figures to be placed on the Right Hand

of the Number answering to the first found *Logarithm*.

Example.

Let 6.64876 be the *Logarithm* given: Suppose 6 to be 4, the nearest *Logarithm* less will be 4.648974, whose absolute Number is 44563. Subtract 4.648974 from the given *Logarithm*, the Remainder is 2; to the Right Hand of which set 00, (because the Characteristick was 6) the Sum is 200; which divide by the common Difference 97, the Quotient is 2, (and an inconsiderable Fraction, which you may omit) which 2 set on the Right Hand of 44563, it makes 445632; but since the Index is 6, the Number must have 7 Places; therefore set 0 on the Right again, and it makes 4456320, which is the Number nearly corresponding to the *Logarithm* 6.648976.

## Addition, Subtraction, Multiplication, and Division in Logarithms.

3. In the Addition of two or more *Logarithms* together, observe these Rules:

1. If the Indices be Integers, add them as is usual in common Arithmetick.

2. If the Indices be some Integers, and some the Indices of Parts or Fractions, they will be *unlike*; and therefore if when added, their Sum be 10, or above, cast away 10, the Remainder is the Index of Integers; if under 10, Decimal Parts: Thus,

$$\begin{array}{r} 2.057821 \\ 7.583210 \\ \hline 9.641031 \\ \hline \end{array} \quad \begin{array}{r} 2.237242 \\ 9.875062 \\ 8.698971 \\ \hline 0.811275 \\ \hline \end{array}$$

3. If the Indices be all Decimals, and when added, make a Sum under 10, then add 10 to the Sum; if just 10, then add Unity; as above 10, cast 10 away, and the Index thus gotten is always Decimal Parts: Thus,

$$\begin{array}{r} 9.397941 \\ 9.875062 \\ \hline 9.273002 \\ \hline \end{array} \quad \begin{array}{r} 8.698972 \\ 9.875061 \\ \hline 8.574033 \\ \hline \end{array}$$

## 4. Subtraction of Logarithms.

1. If the Indices be Integers, then proceed as usually.

2. If the Indices be either of them, or both, decimal Parts, observe whether the Index of the upper Quantity be a smaller Number than that of the subtrahend or the lower; if it be, add 10 to it: And if the upper be of a greater Value than the lower, (that is, a bigger Index by Place) then the Remainder will be Integers; if not, Decimal Parts.

Examples.

$$\begin{array}{r} 2.033421 \\ 9.875062 \\ \hline 2.158359 \\ \hline \end{array} \quad \begin{array}{r} 9.875062 \\ 2.033421 \\ \hline 7.041641 \\ \hline \end{array} \quad \begin{array}{r} 9.875062 \\ 0.574031 \\ \hline 1.301031 \\ \hline \end{array} \quad \begin{array}{r} 1.235781 \\ 3.572141 \\ \hline 7.663640 \\ \hline \end{array}$$



5. The Logarithm of a Fraction is thus found.

Subtract the Logarithm of the Denominator from the Logarithm of the Numerator, the Remainder gives the Logarithm of the Fraction; as of  $\frac{3}{4}$ , the Logarithm of 4 is 0.602060, out of the Logarithm of 3.0477121, the Difference 9.875061 is the Logarithm of  $\frac{3}{4}$ , or 75.

6. To Multiply a Logarithm.

If the Index be Negative, observe, That in multiplying the Figure next the Index, the Tens to be carried in Mind are Affirmative, and are to be deducted out of the Product of the Negative Indices: Thus,

$$\begin{array}{r} 2.543211 \\ 3 \\ \hline 5.629633 \end{array} \quad \begin{array}{r} 1.987214 \\ 5 \\ \hline 1.936070 \end{array}$$

7. To divide a Logarithm, having a Negative or Fractional Index.

Observe whether the Divisor will evenly divide the Index, then there is no Difficulty; but if it do not evenly divide the Index, add to the Index so many Units, till it may be evenly divided, setting the Quotient down for a new Index, augmenting the next Figure by so many times 10 as you added to the first.

$$\begin{array}{r} 3) 5.321412 \\ 2.440470 \end{array} \quad \begin{array}{r} 2) 5.61228 \\ 3.80614 \end{array}$$

8. Multiplication of Numbers by the Logarithms.

Add the Logarithms of the Numbers together, and the Sum is the Logarithm of the Product required.

Multiplicand,	32	1.505150	5.12	0.709265
Multiplier,	52	1.71003	1.55	0.899497
	1664	3.221153	7.936	0.899497

9. Division of Numbers by Logarithms.

This is done only by subtracting the Logarithm of the Divisor from the Logarithm of the Dividend; and the Remainder will be the Logarithm of the Quotient.

Dividend	7286	3.862489	.5512	5.654369
Divisor	32	1.505150	.0315	8.498311
Quotient	227.8	2.357359	1432	1.156058

10. Extraction of Square, Cube, &c. Roots by Logarithms.

To extract the Square Root of any Number, is to divide the Logarithm of that Number by 2, for the Cube Root by 3, &c. That is, in general, divide the Logarithm of the Number, by the Index of the Power.

Number	75832	Log. 4.879852	
Square Root,	275.37	2) 2.439926	for the Square Root.
Cube Root,	42.327	3) 1.626614	for the Cube Root.

11. To find a Mean Proportional betwixt two given Numbers by Logarithms.

Half the Sum of their Logarithms, gives the Logarithm of the Mean Proportional betwixt them.

$$\begin{array}{r} \text{The Numbers are, } \begin{cases} 9 & 0.954242 \\ 16 & 1.204120 \end{cases} \\ \hline \text{Sum, } 2.158362 \end{array}$$

$$\text{Mean Proportional, } 12 \quad S = 1.079181.$$

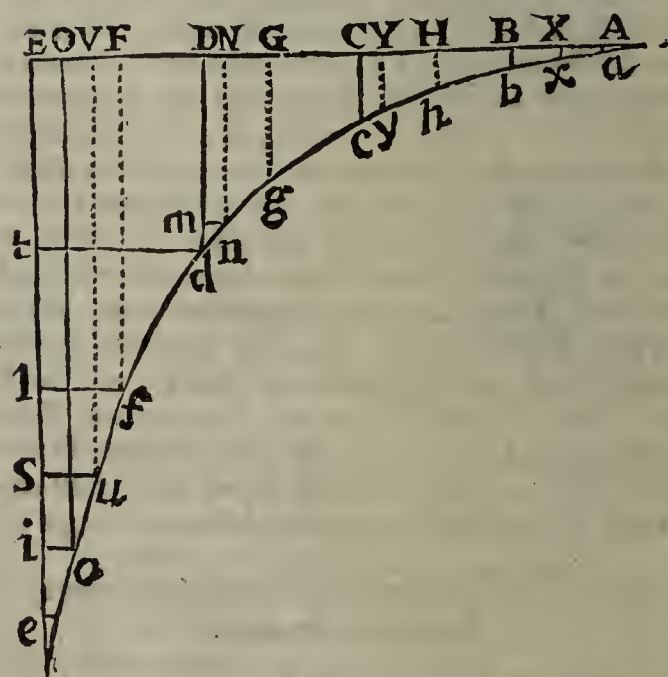
To find any Number of Mean Proportionals betwixt any two Numbers.

Take the Difference of the Logarithms of the two given Numbers, which divide by a Number more by one than the Number of Means desired; and this Logarithmetick Quotient added to the Logarithm of the least, gives the Logarithm of the first Mean next it; and then added to the last Sum, finds the next, &c.

As suppose it were required to find 3 Mean Proportionals between 4 and 64; the Logarithm of 4, is 0.602060; of 64, is 1.806180; their Difference, 1.204120 divided by 4, (i. e. 3 + 1) gives 0.301030; which added to the Logarithm of 4, makes 0.903090, the Logarithm of 8, the first Mean; and again, added to the last Sum, gives 1.204120, the Logarithm of 16; and again added, gives the Logarithm of 32; which are the three Means betwixt 4 and 64.

LOGARITHMICK-LINE of Pardie, is a Curve which discovers perfectly all the Mysteries of Logarithms, with several other very excellent Properties and Uses; and is thus delineated.

Let the Right Line  $AE$  be divided into the equal Parts  $AB, BC, CD, DE$ , &c. from the Points  $A, B, C, D, E$ , &c. let the Lines  $Aa, Bb, Cc, Dd$ , and  $Ee$ , be drawn all perpendicular to  $AE$ , and consequently parallel to one another.



And let them all be in a Geometrical Progression; as let  $Aa$  be 1,  $Bb$  be 10,  $Cc$  100,  $Dd$  1000,  $Ee$  10000, &c. Then shall we have two Progressions of Lines, Arithmetical and Geometrical: For the Lines  $AB, AC, AD, AE$ , are in Arithmetical Progression, or as 1, 2, 3, 4, 5, &c. and so do represent the Logarithms to which the Geometrical Lines  $Aa, Bb, Cc$ , &c. do correspond.

Let



Let each of the equal Parts  $ED, DC, CB, \&c.$  be divided equally again in  $F, G, H$ ; and let the Parallels  $Ff, Gg, \&c.$  be drawn, and be Mean Proportionals between the collateral ones; that is,  $Ee : Ff :: Ff : Dd :: Dd : Gg, \&c.$

Let there also be more Mean Proportionals drawn from the Middle of each Subdivision  $EF, FD, DG, \&c.$  and so on, till these parallel Lines growing very numerous, have at last but a very small Distance from each other: Then imagine a Curve Line drawn through all the Extremities of these parallel Lines, as  $e o u d g b a$ , and this is called the *Logarithmical Line*.

If this Figure were drawn on a very large Table, and with all requisite Exactness, each Part,  $AB, BC, \&c.$  might be divided not only into an 100 or 1000, but even into 10000, 100000 equal Parts, and more: So that  $AB$  being 100000,  $AC$  would be 200000,  $AD$  300000,  $\&c.$  as must always be in an Arithmetic Progression.

The Line  $Ee$  being supposed to contain 10000 Parts, let us imagine through each of those Divisions a Parallel to be drawn to the Line  $AE$ , cutting the Curve in so many Points, *v. gr.* let the Line  $io$  be drawn through the Division 9900 of the Line  $Ee$ , and which cuts the Curve in the Point  $o$ . Let there be also supposed the Parallel  $Oo$ , cutting the Line  $AE$  in the Division 399.63; then any one may know that 399563 is the Logarithm of the Number 9900. In like manner, If  $Su$  passed through the Division 9000 of the Line  $Ee$ , the Line  $Vu$  were drawn cutting  $AE$  in 395424, then would that Line  $uV$  be the Logarithm of 9000,  $\&c.$

So that by this means a Table of Logarithms from 1 to 10000, may easily be made; and farther, by producing the Line  $AE$ .

*Note,* To obtain all the Logarithms from 1 to 10000, 'twill be enough to seek the Logarithms from 1000 to 10000; that is, (having drawn the Parallel  $dt$ ) to take the Logarithms of all the Divisions from  $t$  to  $e$ ; which Logarithms are all contained between  $E$  and  $D$ : For by this you will have the Logarithms of all the Parts that are between  $t$  and  $E$ , and whose Logarithms lie between  $D$  and  $A$ . For Example; Since  $Oo$  is 9900 Parts, and its Logarithms 399563, the same Number may be taken for the Logarithm of 990, which is  $Nz$ : As also of the Number  $Yy$  99, changing only the first Figure 3; because, according to the Composition of this Line,  $ON$  or  $Ny$ , ought to be equal to  $ED$  or  $DC$ ; as any one may easily prove: So that  $ON$  or  $Ny$ , will contain 100000. And because  $AO$  is 399563, subtracting  $ON$  100000, there will rest 199563 for  $Ay$ . And after the same manner, having  $Ay$  395424 for the Logarithm of  $Vv$ , which is 9000, you may have also 095424 for the Logarithm of  $Xx$ , which is 9; or 195424 for the Logarithm of 90; or 295424 for the Logarithm of 900.

All this may be reduced to Practice for Calculation, without actually drawing these Figures, but only imagining them to be drawn: For by the Rules of Common Arithmetick, we may find out  $Ff$ , the Mean Proportional between  $dD$  and  $Ff$ , or between  $Ff$  and  $Ee, \&c.$  But what we have here explain'd, is sufficient to gain the Knowledge of the Nature and Composition of the Logarithms.

Though indeed there will not arise such Advantage for making Logarithms by this Observation, as

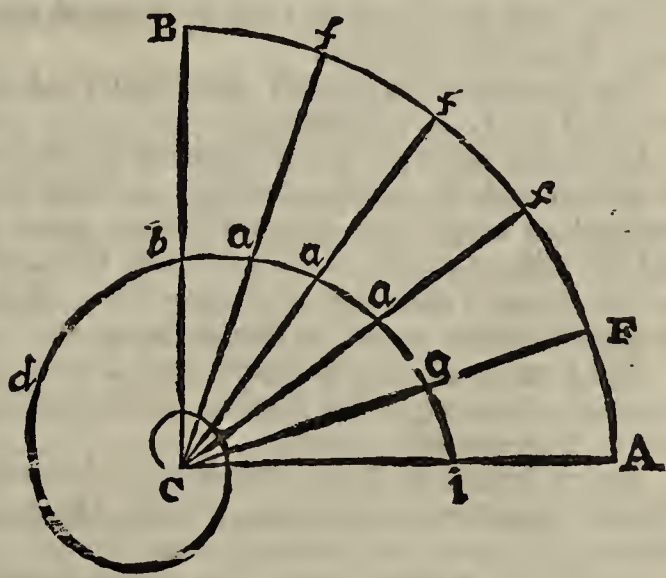
it may at first Sight seem to promise; because there are 9000 Numbers between 1000 and 10000, whose Logarithms must be found also; and but 900 between 100 and 1000, and but 90 between 10 and 100, and but 9 between 1 and 10, and so in all 999, which is not the ninth Part of the former.

In *Phil. Transf.* N<sup>o</sup> 245, is a Quadrature of that Part of the Space contained between any two Ordinates of the Curve and this *Abscissa*, by Mr. *John Craig*; and Dr. *Barrow*, in his *Lectiōes*, hath carried the Matter farther: See in *Phil. Transf.* N<sup>o</sup> 38. an Account of a very short Way of making Logarithms, contrived by *Nicolas Mercator*, with Dr. *Wallis's* Thoughts upon it, and Additions to it.

Mr. *James Gregory* also, in his *Vera Quadratura Circuli & Hyperbolæ*, Printed at Padua, A. D. 1667. applies the Quadrature of the Hyperbola to the making of Logarithms, and computes the Logarithm of 10 to 25 Places.

**LOGARITHMETICK Curve**, is the same with *Pardie's Logarithmetick Line* above described.

**LOGARITHMICK-Spiral**, is a Curve generated by the equable Motion of the Radius of a Circle thro' equal Arks of the Circumference; while at the same time a Point in that Radius is supposed to move from the Ark towards the Centre, with a Retardation of Motion in a Geometric Proportion. As suppose there be a Quadrant of a Circle, as  $BCA$ , and any equal Divisions in the Ark, as  $AF = Ff = ff, \&c.$  with 5 corresponding Radii, suppose as  $CA, CF, Cf, \&c.$  whose Parts or



Portions  $Cr, Ca, Ca, \&c.$  are geometrically proportional; then if a Line, as 1,  $a, a, b, d, C$ , be drawn through those Points, it will be the *Logarithmick-Spiral*. Vid. *Guido Grand. Theorem. Hugen. Cap. 1.*

**LOGARITHMS.** The Learned and Ingenious Mr. *Halley*, Savilian Professor of Geometry in *Oxon.* and F. R. S. hath in *Philos. Transact.* N<sup>o</sup> 216; and since that, in *Sherwin's Mathematical Tables*, published a most compendious and easy Method of constructing the Logarithms; and this exemplified and demonstrated from the Nature of Numbers, without any regard to the Hyperbola, or any other Curves: Together with a speedy Method of finding the Number answering to any given Logarithm. See the Preface to *Sherwin's Math. Tables*, p. 14,  $\&c.$



# An Account of the Origine, Nature, Construction, Uses, and Application of the preceeding Tables of LOGARITHMS.

**T**HE Invention of the Logarithms is justly esteemed one of the most useful Discoveries in the Art of Numbers, and accordingly has had an universal Reception and Applause. And the great Geometricians of this Age have not been wanting to cultivate this Subject, with all the Accuracy and Subtily as a Matter of that Consequence doth require; and they have demonstrated several very admirable Properties of these Artificial Numbers, which have render'd their Construction much more facile, than by those operose Methods, at first used by their truly Noble Inventer, the Lord Neper; and our Worthy Country-Man Mr. Briggs.

But some Account however of the first Invention of these most useful Tables, 'tis proper to introduce here.

Logarithms (saith Dr. Wallis in his Algebra) were first of all invented, without any Example before him that I know of, by John Neper, Baron of Merchiston in Scotland, and by him published at Edinburgh, A. D. 1614. and soon after by himself (with the Assistance of Henry Briggs, Professor of Geometry, first at London in Gresham-College, and afterwards at Oxford) reduced to a better Form and perfected.

The Invention was greedily embraced (and deservedly) by Learned Men.

Mr. Briggs upon the first Publication of it, was so pleased with it, that he presently repaired into Scotland, to consult the Author's Advice about it, and be assistant to him in the perfecting of it, and in calculating Tables for it; which was a Work of great Labour, as well as subtle Invention.

And it was embraced and promoted abroad by Benjamin Ursinus, John Kepler, Adrian Ulaacq, Petrus Cragerus, and others.

And at home, by Henry Gellibrand, who perfected the *Trigonometria Britannica*, which Mr. Briggs began, but died before he had finished it.

So that in a short time it became generally known, and greedily embraced in all Parts, as of unspeakable Advantage; especially for Ease and Expedition in Trigonometrical Calculations.

I have before briefly shewn the Nature and Construction of Logarithms in general, which therefore I shall not repeat here; but go on with their History, and the several Improvements which have been made in this Science, some of which are only barely hinted at there.

A. D. 1614. The Lord Neper published the first Tables of Canon, or Natural and Artificial Sines of each Degree and Minute of the Quadrant.

And whereas it was at his Choice to give to what Number he pleased the Logarithm 0, and whether to proceed by Way of Increase or Decrease, he chose to make 0 the Logarithm of the whole Sine 10000000, that so the Multiplication or Division by the whole Sine (frequent in Trigonometrical Calculation) might be dispatched without Trouble, requiring here but the Addition or Subtraction of 0.

And because the Use of lesser Sines and Numbers less than the *Radius* or whole Sine, were likely to be of more frequent Use, than Tangents, Secants, and other Numbers greater than the *Radius*; he chose to give to those lesser Numbers Affirmative Logarithms (increasing the Logarithms from 0, as the Sines decrease) which he calls *Abundants*: And consequently Negative Logarithms (which he calls *Defectives*) to greater Numbers. Designing those by +, these by —.

And by this means he directs how the Table of Sines (with the Differences there inserted) may serve also for a Table of Tangents, and of Secants; so that this Canon is a compleat Canon, of Natural Sines, and of Logarithmical Sines, Tangents, and Secants.

He shews also how this Table may be applied to the Logarithms of Absolute Numbers; but because with some Trouble, he reserves the fuller Account hereof to a farther Treatise.

In the Year 1619, the Lord Neper being then dead, the same was again published by his Son Robert Neper; with some posthumous Treatises of his Father concerning the Construction of this Logarithmical Canon, and concerning his Design (after Communication had with Mr. Briggs) of changing the Form of his Logarithms, making 0, to be the Logarithm of 1, (of which he had before given Notice in the Preface to his *Rabdologia*, published in the Year 1617;) and concerning some things pertaining to Trigonometry; with some Lucubrations of Mr. Briggs on the same Subject.

But the Lord Neper being dead, the whole Work was devolved on Mr. Briggs, who (according to their joint Advice) making the Logarithm of 1 to be 0; and of 10, 100, 1000, &c. to be 1, 2, 3, &c. which he calls *Indices*, or *Characteristicks*, and which we may repute as Integer Numbers, with fourteen Cyphers annexed, and esteem or value as so many Places, or Decimal Fractions, below the Place of Units, or of the Characteristick: And between these he sets the intermediate Logarithm for the intermediate Numbers.

And consequently the Logarithm of 1 being 0, the Logarithm of Fractions less than 1, or of Numbers intermediate, between 1 and 0, must be Negative Numbers, or Numbers less than 0, which he calls Defective Logarithms, denoted by — (the Note of Negative) prefix'd.

Now these Defective Logarithms may be two ways expressed; either so as that the Note of Negation shall affect the whole Logarithm, or so as to affect only the Characteristick, (leaving the Rest of the Logarithm to be understood as Affirmative.)

As for Example; The Fraction  $\frac{3}{8}$ , or (which is equivalent) 0.375. This Fraction supposeth the Numerator 3 to be divided by the Denominator 8, which in Logarithms, is to be performed by Subtracting the Logarithm of 8, from that of 3, and the Remainder will be the Logarithm of  $\frac{3}{8}$  which will be then the Negative Number, —0.4259687.

Log.



Log. 3.	0. 4771213.
Log. 8.	0. 9030900.
<hr/>	
Log. $\frac{3}{8}$ .	— 0. 4259687.

Or thus; for as much as the Logarithm of 375, (supposing it to be an Integer Number) is 2. 5740313, And the depressing this to the First, Second or Third, or farther Place of Decimal Fractions, doth (without altering the Figures) divide the Value by 10, 100, 1000, &c. which in Logarithms is done by subtracting 1, 2, 3, &c. from the Characteristick, or Place of Integers (1, 2, 3, &c. in that Place being the Logarithms of 10, 100, 1000, &c.) such Alteration of the Value (the Figures remaining) is done by altering the Characteristick of the Logarithm, without varying the other Figures, in this Manner:

Log. 375 <sup>0</sup> =3.	5740313
Log. 375 =2.	5740313
Log. 37 5 =1.	5740313
Log. 3 75 =0.	5740313
Log. 0 375 = <u>1</u> .	5740313
Log. 0 375 =2.	5740313

Which two Forms, tho' they seem different, and some may rather chuse the one, some the other; or in some Cases the one, and in some Cases the other; yet they are in Substance and Value the same. For, by subducting the lower Number from the upper,

$$\begin{array}{r} - 1. 0000000 \\ + 0. 5740313 \\ \hline \text{is} = - 0. 4259687 \end{array}$$

And every one is left to his Liberty whether of the two Ways (or what other Equivalent thereunto) he shall please to use.

In this Method Mr. Briggs hath calculated a Table of Logarithms (published in the Year 1624) for 20 Chiliads of Absolute Numbers (from 1 to 20,000;) and again for 10 more (from 90,000 to 100,000) and one Chiliad supernumerary (viz. the Hundred and First Chiliad) that is, 31 Chiliads in all.

Before which is prefix'd a large Account of the Nature and Construction of the Logarithmical Canon, and the Uses thereof; and directing how to supply the intermediate Chiliads, which are here wanting, The whole intituled *Arithmetica Logarithmica*.

The same was again published in 1628, by *Adrian Ulacq* (or *Flack*) with a Supplement (as Mr. Briggs directed) of the Chiliads before omitted; that is, in all of 100 Chiliads, with one Supernumerary:

But in shorter Numbers extended but to 10 Places below that of the Integers, or Characteristick. And he subjoins also a Logarithmical Canon of Sines, Tangents, and Secants (for Degrees and Minutes of the Quadrant) of as many Places.

Mr. Briggs proceeded to calculate a Trigonometrical Canon, Logarithmical, suited to that for Absolute Numbers to the Logarithms extending (as in that other) to 14 Places besides the Characteristick. And having before calculated a Table of Natural Sines, Tangents, and Secants (for Degrees and Centesims of Degrees) in Number

extending to 15 Places, he fitted thereunto a Canon of Logarithmical Sines, and Tangents (because those of Secants might be spared;) and a Treatise prefixed concerning the Construction thereof, with other Things pertinent thereunto; intending a further Treatise concerning the Use of it.

But dying before this last was finished, or the rest published, Mr. *Henry Gellibrand* supplied this latter, and published the whole with the Title of *Trigonometria Britannica*, in the Year 1633. To which is subjoin'd another Canon of Logarithmical Sines, and Tangents, by *Adrian Ulacq*, for Degrees, Minutes, and Tenth Seconds, extending (as his former did) to 10 Places besides the Characteristick; and Mr. *Briggs* 20 Chiliads for Logarithms of Absolute Numbers.

So that the whole Doctrine of Logarithms was by this time sufficiently perfected, with convenient Canons or Tables fitted thereunto in large Numbers: Of which also *Petrus Cragerus* gives an Account in the Preface to his *Trigonometria Logarithmica*, Printed in the Year 1634, with his Logarithmical Tables, but in short Numbers.

And the Table of Logarithms above-mentioned, (for 100 Chiliads of Absolute Numbers, and of Sines and Tangents to Degrees and Centesims) were the same Year (1633) contracted, into a lesser Form and more manageable (but in shorter Numbers, the former not extending to above 7 Places, beside the Characteristick, but the latter to 10) by *Nathaniel Row*; with Directions for the Use of them (in *Trigonometry*, *Geometry*, *Astronomy*, *Geography*, and *Navigation*) by *Edmund Wingate*.

In the mean time, *Benjamin Ursinus*, did also publish Tables of Logarithms in the Year 1618; and *Claudius Batschius* about the same Time, or soon after. And again *Benjamin Ursinus* in the Year 1625, in his *Trigonometria*; and *Johannes Keplerus* also in the Year 1624, in his *Chilias Logarithmorum* (which he applies also to his *Rudolphine* Tables, published in 1627;) and *Claudius Batschius* about the same Time, or soon after: And *Georgius Ludovicus Frobenius* in the Year 1634, (and perhaps some others.)

But all or most of them in short Numbers, and conformable to the Lord *Neper's* first Design; not to that Form which upon second Thoughts he and Mr. *Briggs* agreed upon as most eligible, and which hath since been received in common Practice.

Thus far Dr. *Wallis*: What follows is the easy and compendious Method of Mr. *Edmund Halley*, Savilian Professor of Geometry in *Oxon*, for constructing Logarithms; which has been mentioned.

The Invention, saith that excellent Geometer, of the Logarithms, is justly esteemed one of the most useful Discoveries in the Art of Numbers, and accordingly has had an universal Reception and Applause: And the great Geometricians of this Age have not been wanting to cultivate this Subject with all the Accuracy and Subtily which a Matter of that Consequence doth require; and they have demonstrated several very admirable Properties of these artificial Numbers, which have rendred their Construction much more facile, than by those operose Methods at first used by their truly noble Inventor, the Lord *Neper*, and our worthy Countryman Mr. *Briggs*.

But notwithstanding all their Endeavours, I find very few of those who make constant Use of Logarithms, to have attained an adequate Notion of them; to know how to make or examine them, or



to understand the Extent of the Use of them; contenting themselves with the Tables of them, as they find them, without daring to question them, or caring to know how to rectify them, should they be found amiss; being, I suppose, under the Apprehension of some great Difficulty therein.

For the Sake of such, the following Tract is principally intended, but not without Hopes however, to produce something that may be acceptable to the most knowing in these Matters.

But first, it may be requisite to premise a Definition of Logarithms, in order to render the ensuing Discourse more clear; the rather because the old one *Numerorum proportionalium æqui-differentes comites*, seems too scanty to define them fully.

They may much more properly be said to be *Numeri Rationum exponentes*: Wherein we consider Ratio as a *Quantitas sui generis*, beginning from the Ratio of Equality, or 1 to 1 = 0; being Affirmative when the Ratio is increasing, as of Unity to a greater Number, but Negative when decreasing: And these Ratios we suppose to be measured by the Number of *Ratiunculae* contained in each.

Now these *Ratiunculae* are so to be understood, as in a continual Scale of Proportions, infinite in Number between the two Terms of the Ratio; which infinite Number of mean Proportionals is to that infinite Number of the like equal *Ratiunculae*, between any other two Terms: as the Logarithm of one Ratio is to the Logarithm of the other: Thus, if there be supposed between 1 and 10, an infinite Scale of mean Proportionals, whose Number is 100000, &c. in infinitum; between 1, and 2, there shall be 30102, &c. of such Proportionals, and between 1 and 3, there will be 47712, &c. of them; which Numbers therefore are the Logarithms of the *Rationes* of 1 to 10, 1 to 2, and 1 to 3; and not so properly to be call'd the Logarithms of 10, 2, and 3.

But if instead of supposing the Logarithms composed of a Number of equal *Ratiunculae*, proportional to each Ratio; we shall take the Ratio of Unity to any Number, to consist always of the same infinite Number of *Ratiunculae*; their Magnitude in this Case, will be as their Number in the former. Wherefore, if between Unity and any Number proposed, there be taken an Infinity of mean Proportionals, the infinitely little Augment or Decrement of the first of those Means from Unity will be a *Ratiunculae*; that is, the *Momentum* or *Fluxion* of the Ratio of Unity to the said Number: And seeing that in these continual Proportionals all the *Ratiunculae* are equal; their Sum, or the whole Ratio, will be as the said *Momentum* is directly; that is, the Logarithm of each Ratio, will be as the Fluxion thereof. Wherefore, if the Root of any infinite Power be extracted out of any Number, the *Differentiola* of the said Root from Unity, shall be as the Logarithm of that Number.

So that Logarithms thus produced, may be of as many Forms as you please, to assume infinite Indices of the Power whose Root you seek: As if the Index be supposed 100000, &c. infinitely; the Roots shall be the Logarithms invented by the Lord Neper; but if the said Index were 2302585, &c. Mr. Briggs's Logarithms would immediately be produced. And if you please to stop at any Number of Figures, and not to continue them on, it will suffice to assume an Index of a Figure or two more than your intended Logarithm is to have; as Mr. Briggs did, who, to have his Logarithms true to 14 Places by continual Extraction of the Square Root, at last came to have the Root of the

140737488355328th Power; but how operose that Extraction was, will easily be judged by whosoever shall undertake to examine his *Calculus*.

Now though the Notion of an infinite Power may seem very strange, and (to those that know the Difficulty of the Extraction of the Roots of high Powers) perhaps impracticable; yet by the Help of that admirable Invention of Sir Isaac Newton, whereby he determines the *Unciae*, or Numbers prefixed to the Members composing Powers (on which chiefly depends the Doctrine of Series) the Infinity of the Index contributes to render the Expression much more easy: For if the infinite Power to be resolved be put (after Sir Isaac Newton's Method)

$$p + p q, \frac{p + q}{1 - m} \quad 1 + q$$

$$\text{instead of } 1 + \frac{1}{m q} + \frac{1}{2 m^2} q q +$$

$$1 - 3 m + 2 m m \quad 1 - 6 m + 11 m^2 - 6 m^3$$

$$\frac{1}{6 m^3} q^3 + \frac{1}{24 m^4} q^4, \&c.$$

(which is the Root when *m* is Finite) becomes

$$1 + \frac{1}{m} q - \frac{1}{2 m} q^2 + \frac{1}{3 m} q^3 - \frac{1}{4 m} q^4 +$$

$$\frac{1}{5 m} q^5, \&c. m^2, \text{ being Infinite, and consequently}$$

whatever is divided thereby vanishing. Hence it follows that  $\frac{1}{m}$  multiplied into  $q - \frac{1}{2} q^2 + \frac{1}{3} q^3 - \frac{1}{4} q^4 + \frac{1}{5} q^5, \&c.$  is the Augment of the first of our mean Proportionals between Unity and  $1 + q$ , and is therefore the Logarithm of the Ratio of 1 to  $1 + q$ ; and whereas the Infinite Index *m*, may be taken at pleasure, the several Scales of Logarithms to such Indices will be as  $\frac{1}{m}$ ; or reciprocally as the Indices. And if the Index be taken 10000, &c. as in the Case of Neper's Logarithms, they will be simple  $q - \frac{1}{2} q q + \frac{1}{3} q^3 - \frac{1}{4} q^4 + \frac{1}{5} q^5 - \frac{1}{6} q^6, \&c.$

Again, if the Logarithm of a decreasing Ratio be sought, the Infinite Root of  $1 - q$ , or  $\frac{1}{1 - q | m}$ , is

$$1 - \frac{1}{m} q - \frac{1}{2 m} q^2 - \frac{1}{3 m} q^3 - \frac{1}{4 m} q^4 -$$

$$\frac{1}{5 m} q^5 - \frac{1}{6 m} q^6, \&c. \text{ whence the Decrement}$$

of the first of our infinite Number of Proportionals will be  $\frac{1}{m}$  into  $q + \frac{1}{2} q^2 + \frac{1}{3} q^3 + \frac{1}{4} q^4 + \frac{1}{5} q^5 + \frac{1}{6} q^6, \&c.$  which therefore will be as the Logarithm of the Ratio of Unity to  $1 - q$ .

But if *m* be put 10000, &c. then the said Logarithm will be  $q + \frac{1}{2} q^2 + \frac{1}{3} q^3 + \frac{1}{4} q^4 + \frac{1}{5} q^5 + \frac{1}{6} q^6, \&c.$  Hence the Terms of any Ratio being *a* and

*b*, *q* becomes  $\frac{b - a}{a}$ , or the Difference divided by the lesser Term, when 'tis an Increasing Ratio; or  $\frac{b - a}{b}$  when 'tis Decreasing, or as *b* to *a*. Whence the Logarithm of the same Ratio may be doubly expressed; for putting *x* for the Difference of the

$$\text{Terms } a \text{ and } b, \text{ it will be either } \frac{1}{m} \times \frac{x}{b} + \frac{x^2}{2 b^2}$$

$$+ \frac{x^3}{3 b^3} + \frac{x^4}{4 b^4} + \frac{x^5}{5 b^5} + \frac{x^6}{6 b^6}, \&c. \text{ or } \frac{1}{m} \times$$

$$\frac{x}{a}$$



$$\frac{x}{a} + \frac{x^2}{2a^2} + \frac{x^3}{2a^3} - \frac{x^4}{4a^4} + \frac{x^5}{5a^5} - \frac{x^6}{6a^6}, \text{ \&c.}$$

But if the *Ratio* of  $a$  to  $b$ , be supposed to be divided into two Parts, *viz.* into the *Ratio* of  $a$ , to the Arithmetical Mean between the Terms and the *Ratio* of the said Arithmetical Mean to the other Term  $b$ ; then will the Sum of the Logarithms of those two *Rationes* be the Logarithm of the *Ratio* of  $a$  to  $b$ ; and substituting  $\frac{z}{2}$  instead of  $\frac{a}{2} + \frac{b}{2}$ , the said *Arithmetical Mean*, the *Logarithms* of those *Rationes* will be by the foregoing Rule,

$$\frac{1}{m} \text{ into } \frac{x}{z} + \frac{x^2}{2z^2} + \frac{x^3}{3z^3} + \frac{x^4}{4z^4} + \frac{x^5}{5z^5} + \frac{x^6}{6z^6}, \text{ \&c. and } \frac{1}{m} \text{ into } \frac{x}{z} - \frac{x^2}{2z^2} + \frac{x^3}{3z^3} - \frac{x^4}{4z^4} + \frac{x^5}{5z^5} - \frac{x^6}{6z^6}, \text{ \&c. the Sum whereof}$$

$$\frac{1}{m} \text{ into } \frac{2x}{z} * + \frac{2x^3}{3z^3} * + \frac{2x^5}{5z^5} * \frac{2x^7}{7z^7}, \text{ \&c. will}$$

be the Logarithm of the *Ratio* of  $a$  to  $b$ ; whose Difference is  $x$ , and Sum  $z$ . And this *Series* converges twice as swift as the former, and therefore is more proper for the Practice of making of Logarithms: which if performed, is with that Expedition; that whereas  $x$ , the Difference, is but the hundredth-part of the Sum, the first Step  $\frac{2x}{z}$  suf-

fices to seven Places of the Logarithm, and the second Step to twelve. But if *Briggs's* first twenty Chiliads of Logarithms be supposed to be made, as he hath very carefully computed them, to fourteen Places, the first Step above is capable to give the Logarithm of any intermediate Number, true to all the Places of those Tables.

After the same Manner may the Difference of the said two Logarithms be very fitly applied to find the Logarithm of Prime Numbers, having the Logarithms of the two next Numbers above and below them: For the Difference of the *Ratio* of  $a$  to

$\frac{1}{2}z$ , and of  $\frac{z}{2}$  to  $b$ , is the *Ratio* of  $a$  to  $b$  to  $\frac{z^2}{4}$ ; and

half of that *Ratio* is that of  $\sqrt{ab}$ , to  $\frac{z}{2}$ ; or of

the Geometrical Mean to the Arithmetical. And consequently the Logarithm thereof will be the half Difference of the Logarithms of those *Rationes*, *viz.*

$$\frac{1}{m} \text{ into } \frac{xx}{2zz} + \frac{x^4}{4z^4} + \frac{x^6}{6z^6} + \frac{x^8}{8z^8}, \text{ \&c.}$$

Which is a Theorem of good Dispatch to find the Logarithm of  $\frac{z}{2}$ .

But the same is yet much more advantageously performed, by a Rule derived from the foregoing; and beyond which, in my Opinion, nothing better can be hoped. For the *Ratio* of  $a$  to  $b$  to  $\frac{z^2}{4}$ , or

$$\frac{a^2}{4} + \frac{ab}{2} + \frac{bb}{4}, \text{ has the Difference of its Terms,}$$

$$\frac{a^2}{4} - \frac{ab}{2} + \frac{bb}{4}, \text{ or the Square of } \frac{a}{2} - \frac{b}{2} =$$

$$\frac{x^2}{4}, \text{ which in the present Case of finding the Lo-}$$

garithms of Prime Numbers, is always *Unity*; and

$$\text{calling the Sum of the Terms } \frac{z^2}{4} + ab = y^2,$$

$$\text{the Logarithm of the } \text{Ratio of } \sqrt{ab}, \text{ to } \frac{a}{2} +$$

$$\frac{b}{2}, \text{ or } \frac{z}{2} \text{ will be found } \frac{1}{m} \text{ in } \frac{1}{yy} + \frac{1}{3y^6} +$$

$$\frac{1}{5y^{10}} + \frac{1}{7y^{14}} + \frac{1}{9y^{18}}, \text{ \&c. Which converges}$$

very much faster than any Theorem hitherto published for this Purpose.

Here note, that  $\frac{1}{m}$  is all along applied to adapt these Rules to all Sorts of Logarithms. If  $m$  be 10000, &c. it may be neglected, and you will have *Neper's* Logarithms, as was hinted before; but if you desire *Briggs's* Logarithms, which are now generally received, you must divide your Series by

2.30258, 50929, 94045, 68401, 79914, 54684, 36420, 76011, 01488, 62877, 29760, 33328:

Or, multiply it by the *Reciprocal* thereof, *Viz.*

0.43429, 44819, 03251, 82765, 11289, 18916, 60508, 22943, 97005, 80366, 65661, 14454.

But to save so operose a Multiplication (which is more than all the rest of the Work) it's expedient to divide this Multiplier by the Powers of  $z$ , or  $y$ , continually; according to the Direction of the *Theorem*; Especially where  $x$  is Small and Integer, reserving the proper Quotes to be added together, when you have produced your Logarithm to as many Figures as you desire, of which Method I will give you a Specimen.

If the Curiosity of any Gentleman, that has Leisure, would prompt him to undertake to do the Logarithms of all Prime Numbers, under 100000 to 25 or 30 Figures, I dare assure him that the Facility of this Method will invite him thereto; nor can any Thing more easy be desired. And to encourage him, I here give the Logarithms of the first Prime Numbers under 20 to 60 Places, computed by the accurate Pen of Mr. *Abraham Sharp*, from whose Industry and Capacity the World may expect in Time great Performances, as they were communicated to me by our common Friend Mr. *Euclid Speidall*.



N.	Log.
2	0.30102, 99956, 63981, 19521, 37388, 94724, 49302, 67681, 89881, 46210, 85413, 10427
3	0.47712, 12547, 19662, 43729, 50279, 03255, 11530, 92001, 28864, 19069, 58648, 29876
7	0.84509, 80400, 14256, 83071, 22162, 58592, 63619, 34835, 72396, 32396, 54065, 03635
11	1.04139, 26851, 58225, 04075, 01999, 71243, 02424, 17067, 02190, 46645, 30945, 96539
13	1.11394, 33523, 06836, 76920, 65051, 57942, 32843, 08297, 29188, 38706, 82718, 01191
17	1.23044, 89213, 78273, 92854, 01698, 94328, 33703, 00075, 67378, 42504, 63973, 80368
19	1.27875, 36009, 52828, 96153, 63334, 75756, 92931, 79511, 29337, 39449, 75989, 06819.

The next Prime Number is 23, which I will take for an Example of the foregoing Doctrine; and by the first Rules the Logarithm of the Ratio of 22 to 23, will be found to be either

$$\frac{1}{22} - \frac{1}{968} + \frac{1}{31944} - \frac{1}{937024} + \frac{1}{25768160}, \text{ \&c.}$$

$$\text{or } \frac{1}{23} - \frac{1}{1058} + \frac{1}{36501} - \frac{1}{1119364} + \frac{1}{32181715}, \text{ \&c.}$$

As likewise that of the Ratio of 23 to 24, by a like Process.

$$\frac{1}{23} - \frac{1}{1058} + \frac{1}{36501} - \frac{1}{1119364} + \frac{1}{32181715}, \text{ \&c.}$$

$$\text{or } \frac{1}{24} - \frac{1}{1152} + \frac{1}{41472} - \frac{1}{1327104} + \frac{1}{39813120}, \text{ \&c.}$$

And this is the Result of the Doctrine of *Mer-  
cator*, as improved by the Learned Dr. *Wallis*.

But by the second Theorem, viz.  $\frac{2x}{z} + \frac{2x^3}{3z^3} + \dots$

$\frac{2x^5}{5z^5}, \text{ \&c.}$  The same Logarithms are obtained by fewer Steps; to wit,

$$\frac{2}{45} + \frac{2}{273375} + \frac{2}{922640625} + \frac{2}{2615686171875}, \text{ \&c.}$$

$$\text{\&c. } \frac{2}{47} + \frac{2}{311469} + \frac{2}{1146725035} + \frac{2}{3546361843241}, \text{ \&c.}$$

Which was invented and demonstrated in the *Hyperbolic Spaces* analogous to the Logarithms, by the Excellent Mr. *James Gregory*, in his *Exercitationes Geometricae*; and since further prosecuted by the aforesaid Mr. *Speidall*, in a late Treatise, in *English*, by him published on this Subject. But the Demonstration, as I conceive, was never till now perfected, without the Consideration of the *Hyperbola*, which is a Matter purely Arithmetical, as this is, cannot so properly be applied. But what follows, I think I may justly claim as my own, viz. That the Logarithm of the Ratio of the Geometrical Mean to the Arithmetical between 22 and 24, or of  $\sqrt{528}$  to 23, will be found to be either,

$$\frac{1}{1058} + \frac{1}{1119364} + \frac{1}{888215334} + \dots$$

$$\frac{1}{626487882248}, \text{ \&c. or, } \frac{1}{1057} + \dots$$

$$\frac{1}{3542796579} + \frac{1}{659676558485285}, \text{ \&c.}$$

All these Series being to be multiplied into 0.4342944819, &c. if you design to make the Logarithm of *Briggs*. But with great Advantage with respect of the Work, the said 4342944819, &c. is divided by 1057, and the Quotient thereof again divided by three Times the Square of 1057, and that Quotient again by  $\frac{2}{3}$  of that Square, and that Quotient by  $\frac{2}{7}$  thereof, &c. till you have as many Figures of the Logarithm as you desire. As for Example, the Logarithm of the Geometrical Mean between 22 and 24, is found by the Logarithms of 2, 3, and 11 to be

1057) 43429, &c.  
3 in 1117249) 41087, &c.  
 $\frac{2}{3}$  in 1117249) 12258, &c.  
5 in 1117249) 65832, &c.  
 $\frac{2}{5}$  in 1117249) 42088, &c.

1.36131696126690612945009172669805  
41087462810146814347315886368  
12258521544181829460074  
6583235184376175  
4208829765  
2930

Sum 1.36172783601759287886777711225117

Which is the Logarithm of 23, to 32 Places, and obtained by five Divisions only, with very small Divisors; all which is much less Work, than simply multiplying the Series into the said Multiplier 43429, &c.

Before I pass on to the Converse of this Problem, or to shew how to find the Number appertaining to a Logarithm assigned, it will be requisite to advertise the Reader, that there is a small Mistake in the aforesaid Mr. *James Gregory's Vera Quadratura*



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that is  $a + \frac{al}{\frac{1}{m} - \frac{1}{x}}$ , and  $b = \frac{bl}{\frac{1}{m} + \frac{1}{x}}$ , or  $\frac{\frac{1}{m}a + \frac{a^2}{x}}{\frac{1}{m} - \frac{1}{x}}$ , and



and  $\frac{\frac{1}{m}b - \frac{1}{2}}{\frac{1}{m} + \frac{1}{2}}$ , which are easily resolved into Analogies, viz.

As 43429, &c.  $-\frac{1}{2}$ : to 43429  $+\frac{1}{2}$ : so is  $a$  to the Number sought. Or

As 43429, &c.  $+\frac{1}{2}$ : to 43429  $-\frac{1}{2}$ : so is  $b$  to the Number sought.

If more Steps of this Series be desired, it will be found as follows.

$$a + \frac{al}{1 - \frac{1}{2}} - \frac{\frac{1}{2}al^2}{1 - l} + \frac{\frac{1}{3}al^3}{1 - 2l}, \text{ \&c. As}$$

may easily be demonstrated by working out the Divisions in each Step, and collecting the Quotes, whose Sum will be found to agree with our former Series.

Thus, I hope, I have cleared up the Doctrine of Logarithms, and shewn their Construction and Use independent from the *Hyperbola*, whose Affections have hitherto been made use of for this Purpose; tho' this be a Matter purely Arithmetical, nor properly demonstrable from the Principles of Geometry; nor have I been obliged to have Recourse to the Method of Indivisibles, or the Arithmetick of Infinities; the whole being no other than an easy Corollary to Sir Isaac Newton's General Theorem for forming Roots and Powers.

What is the Interest of 5173 *l.* for 321 Days, at 6 *l. per Centum*?

Write down first the *Arith. Comp.* of the Logarithm of 100 = 8.0000000  
 Next under it the *Arith. Comp.* of the Logarithm of 365 = 7.4377071  
 The Logarithm of 6 = 0.7781512  
 The Logarithm of the Principal 5173 = 3.7137425  
 The Logarithm of the Days 321 = 2.5065050  
 The Sum of all is the Answer = 2.4361058

For rejecting the first 2 in the Characteristick you will find the Number answering to the Logarithm 2.4361058 to be 272 *l.* 964; and Reason will direct you where to make your Decimal Points in the Number 272964; for the Interest in that Time can't be so much as 2729 *l.* nor so little as 27 *l.* as well as the Rule determines that Number to con-

How easily and compendiously Logarithms may be made according to this Method of Mr. Halley's, as also from the Quadrature of the *Hyperbola*; the Reader may be fully satisfy'd from Mr. Hen. Sherwin's Introduction to his *Excellent Mathematical Tables*, London, 1705; where also is a Method for computing the natural Sine, Tangent, or Secant of any Arch immediately, from having only the Length of the Arch given, &c.

#### Some further Uses of the Logarithms.

1. To find the Arithmetical Complement of a Logarithm.

Suppose 2.5065050

Its Compl. Arith. 7.49349410

Begin at the Left-hand, and write down under it the Complement of each Figure to 9, but of the last to 10.

N. B. This is all one with subducting the Logarithm from 10.0000000. And 'tis frequently of good Use to take the Complement Arithmetical of a Logarithm instead of the Logarithm itself; especially when there are two or more Logarithms in any Case to be subtracted: For then adding their Arithmetical Complements, will answer the End as truly as subtracting the Logarithms themselves.

As suppose in the double Rule of Three, you had this Question about Interest.

As suppose; At 6 *l. per Cent.* What is the Interest of 15 *l.* 7 *s.* 6 *d.* for 12 Years?

Write down first the Logarithm of 1.06, which expresses the Rate of Interest. } = 0.0253058

Which Logarithm multiplied by 12, makes = 0.3036696  
 Then write down the Logarithm of the Principal, viz. of the Decimal 15.875 = 1.2007137

The Sum of which two last Logarithms added into one Sum = 1.5043833

Which is a Logarithm answering to the absolute Number, = 31.94362  
 A Decimal expressing 31 *l.* 18 *s.* 10 *d.*  $\frac{1}{2}$  *q.* nearly.

3. It will be very necessary rightly to understand the Use of the Tables of Logarithms with regard to Decimal Fractions. For the Rule for finding the Logarithm of a Fraction being; To subtract the Logarithm of the Denominator from the Logarithm of the Numerator, and to take the Remainder as the Logarithm of the Fraction required: That Logarithm of the Remainder must always be the Lo-

garithm of a *Decimal Fraction*, whose Value is the same with that of a *Vulgar Fraction* proposed.

Wherefore the most natural, easy, and useful Way to find the Logarithm of a Fraction, is this:

Suppose the Index of the Logarithms of all Numbers from 1 to 10, to be 10 or 100, from 10 to 100, to be 11 or 101; from 100 to 1000, to be 12 or 102; from 1000 to 10000, to be 13 or 103, and



and so upwards: This being allowed, the Index of the Logarithm of a Number, one Place below Unity, must be 9, or 99; if two Places below Unity, it must be 8, or 98; if three Places below Unity, it must be 7, or 97; if four Places below

Unity, then the Index must be 6, or 96; the *latter of these Ways* is often convenient to distinguish the Index of a whole Number, from that of a *Decimal Fraction*, and often necessary when the Power of the Root of a *Decimal Fraction* is required.

*Example*, The Logarithm of  $\frac{3}{4}$  is found thus: 3 Log. 0.4771213  
From which subtract the Denominator, 4 Log. 0.6020600

The Remainder is the Logarithm of .75 Log.—9.8750613

*Note*, That the Denominator of a proper Fraction, is always greater than its Numerator; so that supposing the Index of the Logarithm of 3 to be 10, or 100, the Index of the Remainder will be 9, or 99, (that is, one Place below Unity) and the rest of the Logarithms, except the Index, is found in the Table of Logarithms to answer to 75, 750, 7500, 075, 75, or any other Number, whose two significant Figures are 75, and those which follow or proceed, all Cyphers. It was the former of these Ways by which Mr. Briggs and Mr. Gunter made the Characteristicks of their Tables of Logarithmetick Sines and Tangents; where it may be noted, when the natural Sine or Tangent is a *Decimal Fraction* only, the Index is under 10; but where it is a mixt Number, there the Index is 10, or more: For *Example*, The natural Tangent of 5

Degrees is .0874887, the artificial 8.9419518; and the natural Tangent of 85 Degrees, 11.430052, the artificial is 11.0580482.

But it is needless to use these new Indices, except some Term given or sought, be less than an Unit.

#### 4. To find the Logarithm of a mixt Number.

Reduce the Number given into an Improper Fraction, then subtract the Logarithm of the Denominator from the Logarithm of the Numerator, the Remainder is the Logarithm sought.

*Example*. Let  $4\frac{2}{3}$  be the mixt Number given; this reduced to an Improper Fraction is  $\frac{14}{3}$

The Logarithm of the Numerator, viz. 14, is 1.7558748  
The Logarithm of the Denominator, viz. 3, is 1.0791812

The Logarithm of  $4\frac{2}{3}$ , =  $4\frac{2}{3}$ , whose Logarithm is 0.6766936

If the Fraction annexed be a Decimal, seek for it as if it were a whole Number, observing to prefix to its Logarithm a suitable Index; which always is an Unit less than the Number of Places,

The Index of the Logarithm of 47500 is 4, because the Absolute Number consists of 5 Places, for the same Reason in 475, the Index of its Logarithm is 2, in 47.5 it is 1; but the Index of a proper Decimal Fraction, is so many Units as the Cyphers before it wants of 9, or 99; so the Index of .0475 is 8, or 98, and of .00475 is 7, or 97.

#### Of raising Powers by Logarithms.

Multiply the Logarithm of the Number given by the Index of the Power required, the Product will be the Logarithm of the Power sought: So the Logarithm of  $32 = 1.5051500 \times 3 = 4.5154500$ , the Logarithm of 32768, which is the Cube of 32.

In the Multiplication, or Raising of Powers, viz. Squaring, or Cubing, &c. of any Decimal Fraction by Logarithms, the Index of the Logarithm of the Product or Power, must consist of so many Units as the Number of Cyphers intercepted between the Place of Units, and the first significant Figure in the natural Number wants of 9.99.999, &c. only to the Index of the Logarithm of the Power (i.e. the Square, or Cube, &c.) there will be such a Figure prefix'd as wants an Unit of the Index of that Power, or Number, by which the Logarithm was multiplied: For

*Example*, Let the Cube of .009 be required; the Logarithm of .009 is  $7.9542425 \times 3 = 23.8627275 = .000000729$ , the Cube of .009, and the Index of the Logarithm of the Power, or Product is 3;

in the whole Number to which it belongs; which is further illustrated by the adjoining Table, where the Logarithms, except the Index, are the same in these Eight *Examples*.

Numbers.	Logarithms.
47500   4.	6766936
4750   3.	6766936
475   2.	6766936
47.5   1.	6766936
4.75   0.	6766936
.475   99, or,	9.6766936
.0475   98, or,	8.6766936
.00475   97, or,	7.6766936

therefore 6 Cyphers must precede the first significant Figure of the natural Number; and 2 is prefix'd since the Index or Number multiplying was 3. But when the Numbers of Cyphers, preceding the significant Figures of the Power or Product, exceeds 10, 'tis necessary to admit another Figure into the Index of the Logarithm, and make it the Complement to a Hundred: As suppose the 6

Power, or the Cube—Cube of the Sine of 0—1 be requir'd, its Logarithm in the Table is 6.4637261; but in this Case must be 96.4637261; which multiplied by 6, the Index of the Power proposed, becomes 578.7823566, whose Index being 78, subtracted from 99, leaves 21 for the Number of Cyphers that must precede the first Figure of the natural Number or Power, which is .00000000000000006058383. Here the Figures preceding the Index, as the Result of the Multiplication is 5, less by an Unit than the Number multiplying, being 6, the Index of the Power.

This suggests a certain Rule for Extracting the Roots of Fractions by the Logarithms; viz. Prefix a Figure to the Index of the Logarithm of the Number



Number whose Root is to be extracted, less by an Unit than the Index proper to the Root required, which is to be the Divisor; then divide the whole Logarithm together with its Index and Number prefixed by that Index, the Quotient is the Logarithm of the Root desired. *Ex. gr.* If the *Cube-Root*, or Root of the 6 Power of .00000000000000006058383, whose Logarithm is 78.7823566, be demanded; prefix 6 — 1, *i. e.* 5 to its Index, it is then 578.7823566; which being divided by 6, the Index proper to the Root sought, the Quotient is 96.4637261, whose natural Number is .0002908882; 3 Cyphers preceeding the first Figure, because the Index 96 wants so much of 99. But when the Root of an absolute Number is required, there needs no Figure to be prefixed to the Index of its Logarithm; since it is always supposed, that the Index of the Power (which must be the Divisor) preceeds it. *Ex. gr.* If the *Cube-Root* of 6751269, whose Logarithm is 6.82993854, be required, it is an indifferent Thing, whether 3, the Index of the Root to be extracted, be prefixed or not, since that alters nothing: For 3)36.82993854( Quotes 12.2764618, the Logarithm of 189, the Root sought.

*Another Method to Raise any Power of a Decimal Fraction.*

Multiply the Arithmetick Complement of the Logarithm of the Fraction given by the Index of the Power required, the Arithmetic Complement of the Product is the Logarithm of the Power sought: For instance, the .625 Power of .0032 is found to be .0275879.

.0032 Logarithm	7.5051500
Arithmetic Complement	2.4948500
Multiply by	.625
	124742500
	49897000
	149691000
Product	15592812500
Its Arithmetic Complement	8.4407187500

*Note,* That so many Cyphers must the Logarithm of .0275879, preceed the Fraction as the Index of its Logarithm wants Units of 9, or 99, which in this Example is 1, and in the next 15, being always the same Number with the Index of the Product.

Again; Let the 6.25 Power of .0032 be sought: The Logarithm of .0032 (as before) is 7.5051500, and its Arithmetic Complement 2.4948500  $\times$  6.25 = 15.5928125, its Arithmetic Complement is 84.4071875; which answers to .00000, 00000, 00000, 25538, which is the 6.25 Power of .0032.

*To extract any Root of a Decimal Fraction.*

Divide the Arithmetical Complement of the Logarithm of the Fraction given, by the Index of the Root required, the Arithmetical Complement of the Root sought: For instance, let the .625 Root of .0275879 be required, its Logarithm is 8.4407188, and its Arithmetical Complement = 1.5592812 divided by .625, the Quotient is 2.4948500, and its Arithmetic Complement is 7.5051500 the Logarithm of .0032, which is the Root required.

Again; Let the 6.25 Root of .00000, 00000, 00000, 25538 be required, its Logarithm is 84.4071875, and its Arithmetic Complement is 15.5928125, divided by 6.25, the Quotient is 2.4948500, and its Arithmetic Complement is 7.5051500 the Logarithm of .0032, the Root required.

LOGICK, is the Art of right Thinking, or using our Rational Faculty aright: And the Power or Force of Reason, unassisted by Art, is called *Natural Logick*.

*Logick* is derived from those Reflections which Men have made on the Four principal Operations of the Mind, *viz.* *Apprehension, Judgment, Discourse,* and *Method* or *Disposition*; which see.

The Business of *Logick* is chiefly to teach us how to make proper Animadversions on the Operations of our Minds; and from its true Use we gain these three Advantages.

*First,* We are thereby assured that we make a right Use of our Reason: For the Consideration of Rules, begets in us a more fervent Application and attentive Industry of the Mind.

*Secondly,* That thereby we more easily detect and explain the Errors and Defects which we meet with in the Operations of the Mind: For oftentimes it falls out, that we discover by the meer Light of Nature the Faults of Ratiocination; yet are not able to give a Reason why it is false: Thus they who know not what belongs to Painting, may take Exceptions at the Defects of a Picture, tho' they are not able to tell the Reason why they find fault.

*Thirdly,* That we are brought to a more accurate Knowledge of the Nature of our Understanding, by these Reflections upon the Operations of the Mind, which, if we look no farther than meer Speculation, is to be prefer'd before the Knowledge of all Corporeal Things.

LOGISTICA *Linea*, is that which is otherwise called the *Logarithmick Line*; where the Ordinates applied in equal Parts of the Axis are in Geometrical Proportion.

LOGISTICAL *Arithmetic* [*λογιστικὴ ἀριθμητική*, Gr. *an expert Accomptant*] was formerly the Arithmetic of Sexagesimal Fractions, and used by Astronomers in their Calculations. I suppose it was so called from a Greek Treatise of one *Barlaamus Monatias*, who wrote about Sexagesimal Multiplication very accurately, and entitled his Book *λογιστική*. This Author *Vossius*, in his Book *de Scientiis Mathematicis*, places about the Year 1350, but mistakes it for a Treatise of *Algebra*.

Thus also *Shakerly*, in *Tabulae Britannicae*, hath a Table of *Logarithms* adapted to Sexagesimal Fractions, which therefore he calls *Logistical Logarithms*; and the expeditious Arithmetick of them, which is by this Means obtained, and by which all the trouble of Multiplication and Division is saved, he calls *Logistical Arithmetic*; though some by

LOGISTICKS, will understand the first general Rules in *Algebra* of *Addition, Subtraction, &c.*

LOGISTICK *Spiral*. See *Logarithmick Spiral*.

LOGOGRIPE [*of λόγος, a Word, and γρίψ, Gr. a Net.*] a kind of Symbol or Riddle propos'd to Students, in order to exercise and improve their Mind. It commonly consists of some equivocal Allusion or Mutilation of Words; which being taken literally, signify something different from the thing intended by it: So that it is a Medium between a *Rebus* and a proper *Ænigma*. *Kircher* calls them a sort of speaking Arms. So



So one *Leonard*, who bore in his Coat of Arms a Lion and Nard, or *Spikenard*, made it *Logogriphe*.

*Kircher* also defines a *Logogriphe* to be an *Ænigma* which bears various Meanings under one Name or Word, by adding or retrenching some part of it.

LOHOCH, or *Loch*, the same with *Eclegma*.

LOINS [in *Anatomy*] are the lower part of the Spine of the Back, compos'd of five *Vertebrae*, which are larger than those of the Back, and serve them as a Basis, having their Articulations pretty loose, that the Motion of the Loins may be more free.

LONCHITES, [*λογχίτης*, Gr.] or *Hastiformis*, a Species of Comets resembling a Lance or Spear: Its Head is of an Elliptick Form, and its Tail or Stream of Rays very long, thin, and pointed at the End.

LONG Accent, in Grammar, shews that the Voice is to stop upon the Vowel that has that Mark, and it is expressed thus, (-).

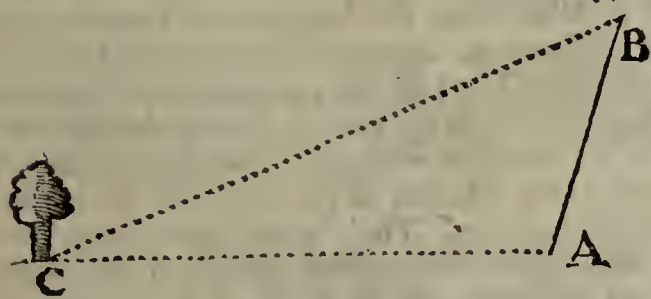
LONG-BOAT, is the largest and strongest Boat belonging to a Ship, that can be hoisted aboard of her: Its Use is to bring any Goods, Provision, &c. to or from the Ship; or, on occasion, to land Men any where; and particularly to weigh the Anchor; for which End she hath a *Davit* to be set over her Head, with a *Shiver* in it, in which the *Buoy-rope* runs, to weigh the Anchor. She hath Mast, Sail, and Oars, as other Boats, as also her *Tiller* to the Rudder, which answers to the *Helm* of a Ship.

LONGANON, the last Gut: See *Intestinum rectum*.

LONGIMETRY, [of *Longus*, L. and *μετρέω*, Gr. to measure] is the Art of measuring Lengths or Distances: Or to take the Distances of *Trees*, *Steeple*s, or *Towers*, &c. either one or many together; for which Purpose the *Theodolite* is reckoned to be the best Instrument, whereof we'll give the following Instances.

#### To Measure one single Distance.

As suppose you stand at *A*, and would know the Distance to the Tree at *C*.



1. Set your Instrument at *A*, laying the *Index* with *Sights*, on the North and South Diameter, and turn it about till through the *Sights* you see the Tree at *C*, there fix your Instrument fast.

2. Then from *A*, measure any Number of Feet, Yards, or the like, any way; as to *B* 100 Foot, and set up a Mark at *B*.

3. Take the Angle *BAC*, 120 Deg. 10 Min. which set down.

4. Set a Mark at *A*, and remove your Instrument to *B*, and take the Angle *ABC* 50 Degrees.

Now you have an *Oblique Angled Triangle*, wherein there is given the Angles *BAC* 120 Deg. 10 Min. *ABC* 50 Deg. and the Distance *AB* 100 Foot, and consequently the Angle *C* 9 Deg. 50 Min. (being the Complement of the other two, to 180 Deg.

Then *S. BCA : AB :: S. CBA : AC*.

$$9^{\circ} 50' : 100 :: 50^{\circ} 00' : 448, 6$$

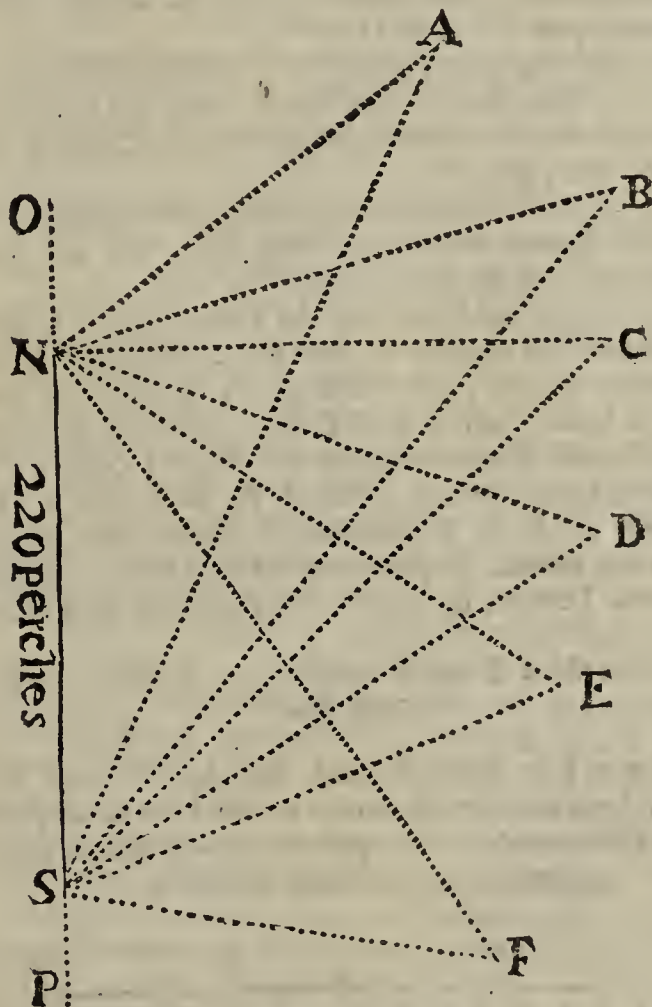
And *S. CBA : CA :: S. compl. CAB : CB*

$$50^{\circ} 00' : 448, 6 :: 59^{\circ} 50' : 506, 2$$

So the Distance from *C* to *A* is 448, 6 Foot, and from *C* to *B* 506, 2 Foot.

How to take the Distances of divers Things remote from you; as, Churches, Towers, Ships at Sea, or such like; and to make a Map of the same.

Suppose that the Points *A*, *B*, *C*, *D*, *E* and *F*, were Houses, Churches, Towers, or the like, and that it was required to make a Draught of them, representing their Situation and true Distance one from another.



Let your Stations be *S* and *N*. Set your Instrument at *N*, and turn it about upon the Socket till the Needle hang directly over the *Meridian Line* of the *Card* in the Bottom of the Box, the North end of the Needle over the *Flower-de-lis*; then skew your Instrument fast.

Then turn the *Index* about, till through the *Sights* you see *A*, and note what Degree the *Index* cuts, which suppose to be 60. Then turn the *Index* about till you see *B*, and mark what Degrees it cut by the *Index*; as 74 Deg. 30 Min. Do thus with all the rest, be there never so many.

Also measure the Distance between *N* your first Station, and *S* the second Station; which is 220 Perches: And bring your Instrument from *N* to *S*, where it must be set up, laying the *Index* upon the North and South Diameter: Turn it about till you see the first Station *N*, then fix it.

And turn the *Index* about, till thro' the *Sights* you see *A*, and note what Degrees the *Index* cutteth; as 31 Deg. 30 Min. Then turn the *Index* about to *B*, *C*, *D*, &c. noting the Degrees cut by the *Index* at every moving, and set them down in a Table ruled for that Purpose, thus,



	At the first Station the Index cut.		At the second Station the Index cut.	
	D.	M.	D.	M.
A	60	00	31	30
B	74	30	38	40
C	84	30	43	20
D	104	50	54	00
E	117	00	68	10
F	145	10	97	00

Stationary Distance is  
220 Perches.

*How to protract these Observations.*

1. Draw a Line at Length, as  $OP$ ; whereon take any Point, as  $N$ , for your first Station: Apply the Center of your Protractor to  $N$ , and its Diameter upon the Line  $OP$ .

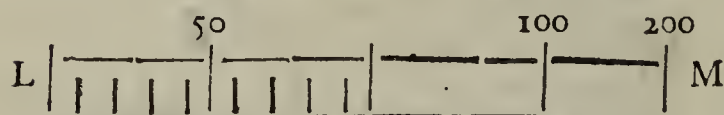
2. Having your Table of Observations before you, prick off the Degrees observed, along the Limb of your Protractor, and draw the obscure Lines  $NA$ ,  $NB$ ,  $NC$ , &c.

3. From some Scale of equal Parts (answerable to the Bigness you intend your Plot) take off 220 Perches, and set them from  $N$  to  $S$ .

4. Apply the Center of the Protractor to  $S$ , and its Diameter upon  $OP$ , and prick off your Observations at the second Station; and draw the obscure Lines  $SA$ ,  $SB$ ,  $SC$ , &c. (from  $S$ , through the several Marks made on the Paper) cutting the Lines drawn before,  $NA$ ,  $NB$ ,  $NC$ , &c. in the Points  $A$ ,  $B$ ,  $C$ ,  $D$ , &c. which Points shall represent the several Ships as they lie at Anchor; or the several Towers, or remarkable Places to be plotted.

*To make a Scale to measure any Distance upon this Plot.*

Let a Line be so divided, that the Distance  $NS$  may be 220 Parts thereof, as the Line  $LM$ ; for the Distance  $NS$ , set upon this Scale, which reach from 200 to 20 on the small Divisions.



And the Scale being thus divided and numbred, you may measure any Distance upon the Plot.

*To measure any Distance, thus laid down, by Trigonometrical Calculation.*

The Visual Lines made at both Stations by their Intersections, do constitute several *Right-lined Triangles*; in either of which you will have enough given to find whatsoever Distance you shall require; as suppose the Distance  $NA$  were required.

In the *Right-lined Triangle ANS*, you have given, the Angle  $ANS$ , 120 Deg. (being the Complement of 60 Deg. the Angle observed at  $A$ , to 180 Deg.) the Angle  $NSA$  31 Deg. 30 Min. being the Complement of the other two, to 180 Deg.

Therefore, as  $S, NAS : NS :: S, NSA : NA$ .

To find  $AS$ , say,

As,  $S, NAS : NS :: S, ANS : AS$ .

By the same Method any other Distance may be found: And in this manner may the Maps or Plots of all eminent Places in Cities, Towns, &c. be taken.

**LONGISSIMUS Dorsi** [in *Anatomy*] a Muscle of the Back, which at its beginning, is not to be distinguished from the *Sacro Lumbaris*, with which it arises from the hinder part of the *Os ilium* and *Os sacrum*, and the first Vertebra of the Loins. It runs upwards along the whole Tract of the Back, and is connected by Tendons in each transverse Process in its way, and ends sometimes in the first Vertebra of the Back, and at other times in the first of the Neck; and now and then reaches to the *Processus Mammillaris* of the *Os Petrosum*, as some Authors say. This, in Conjunction with some others, helps to keep the Body erect.

**LONGISSIMUS Oculi** [in *Anatomy*] the Name of a certain Muscle, *L*.

**LONGISSIMUS Pollicis**: See *Flexor tertii Internodii*.

**LONGISSIMUS Femoris**; vid. *Sartorius*.

**LONGITUDE** of a Place, is only the Distance counted in the Equator between its Meridian, and the first; or indeed between that and any other: It may be found by the Difference of Time between the coming of any Point in the Heavens first to one Meridian and then to the other. For every  $15^\circ$  of the Equator answering to an Hour in Time, one Degree of it being 4 Minutes of Time, and one Minute of a Degree there being 4 Seconds of Time; and 15 Minutes 1 Minute of Time; the Difference of Time being turned into Degrees, will truly give the *Longitude*, or *vice versa*. Hence several Ways have been thought of to find the Longitude at Sea; the great *Desideratum* of the Art of Navigation: As by the Eclipse of the Moon, her Transit over or Appulse to any eminent fix'd Star; the Eclipses of Jupiter's Satellites, &c. which are all true in Theory, and may be practised ashore with the greatest Exactness. For the Time of any one of these *Phænomena* being truly calculated for the Meridian of London (suppose, or any other:) And Tables may be easily made of all of them, which the Navigator may carry to Sea with him. If then he could but observe the Time of the Eclipse or Transit at Sea with accurate Exactness, the Difference of Time of the Eclipse happening to him sooner or later than at London, would give him the exact Longitude of the Place of the Ship either East or West from the Meridian of London. But the Misfortune is, such an Observation of an Eclipse, and the exact Time of the Immersion or Emergence of the deficient Body into or out of the Shadow, is not to be made without Telescopes of such a Length as the Motion of the Ship will not permit to be used at Sea. Tho', by the by, if Ships were sent with good Instruments and Men that know how to use them, to do this at all the Capes and Head-lands of the World; it would be a Thing of the greatest Use; and by settling the Longitude of all those Places, would cut all long Voyages into many short ones, and afford means of continually rectifying the dead Reckoning at Sea. But to return: Others being fully satisfied of the Impracticableness of the Method of Eclipses for finding the Longitude at Sea, have happily thought of doing it by a Clock or Watch: Which if indeed it could be made to go right all the Time of a long Voyage, would infallibly give the Longitude at any Time when the true Hour of the Day or Night could be had under any Meridian or in any Place of the Earth: For the Clock going true for the Meridian it was first set at, will shew the true Hour exactly in that Place, and then the true Hour being found by the Sun or Stars in the Place where the Ship is, the Difference between that and the Clock's



Hour, will be the Difference of Meridians in Time, or Longitude in Degrees. But no such Movement hath ever yet been made, and I fear scarce ever will, which will keep going, and going true in all Climates, and especially in some of the *Southern* ones, where the Dews are so great as to rust the Parts of it, and so retard, if not stop its Motion entirely. I don't mention the Inconvenience arising from the Motion of the Ship, because I believe that may be obviated, and a Movement made to go true notwithstanding that, as perhaps the World may see in some Time, there being now some very ingenious and skillful Heads and Hands employing themselves that Way. But in the mean while, I judge the best Way would be to depend on the Movement only for 24 Hours; for if it will go true for so long, by the Motion of the fix'd Stars, it may be rectify'd every Day to the Stars or Sun's Hour; and so will shew the Difference of Longitude the Ship hath gained in that Time. How the Seamen find their *Departure of Longitude* by Trigonometrical Calculation, you will find in *Plain and Mercators Sailing*.

**LONGITUDE of a Place**, is an Ark of the *Equator* intercepted between the Meridian of that Place, and the *first Meridian*: Or 'tis more truly the Difference, either *East* or *West*, between the *Meridians* of any two Places, counted on the *Equator*.

**LONGITUDE in the Heavens**, is an Ark of the *Ecliptick*, counted from the beginning of *Aries*, to the Place where the Stars Circle of Longitude crosses the *Ecliptick*: So that 'tis much the same as the *Stars Place in the Ecliptick*, reckoned from the beginning of *Aries*; which how to find, see *Place of the Sun or Star*.

**LONGITUDE of the Sun or Star from the next Equinoctial Point**, is the Number of Degrees and Minutes they are from the beginning of *Aries* or *Libra*, either before or after them; which can never be more than 180 Degrees.

**LONGITUDE in Navigation**, is also the Distance of a Ship or Place, East or West from another (counted in proper Degrees); but if in Leagues or Miles, or Degrees of the Meridian, and not in those proper to the *Parallel of Latitude*, it's commonly called *Departure*.

**LONGITUDE in Dyalling**. The Ark of the Equinoctial, intercepted between the Substilar Line of the Dial and the true Meridian, is called the *Planes Difference of Longitude*.

*To find the Longitude and Latitude of any Star by the Globe.*

Bring the Solstitial Colure to the Brass Meridian, and there fix the Globe; then will the Pole of the *Ecliptick* be just under 23 Deg. 30 Min. accounted from the Pole above the Horizon, stand on the same Meridian: There skrew the Quadrant of Altitude, and then bring its graduated Edge to the Star, and there stay it; and so the Quadrant will cut the *Ecliptick* in the *Star's Longitude*, as also its *Latitude* on the Quadrant, reckoned from the *Ecliptick*.

**LONGITUDE of Motion**, is a Term used by Dr. Wallis in his *Mechanicks*, and others, for the Measure of Motion estimated according to the Line of Direction; so that 'tis the Distance or Length which the Center of any moving Body runs through, as it moves on in a Right Line.

And he calls the Measure of any Motion estimated according to the Right Line, or Line of Direction of the *Vis Motrix*, the *Altitude* of it.

**LONGUS**, a Muscle of the *Cubit*, which helps to extend the Arm forwards.

**LONGUS**, a Muscle of the *Radius*, serving to turn the Palm of the Hand upwards.

**LONGUS**, a Muscle of the *Tarsus* so called: See *Peroneus Primus*.

**LONGUS Colli**, is a Muscle of the Neck, which arises partly tendinous, but chiefly fleshy, from the fore-part of the Five *Vertebrae* of the *Thorax*; and being dilated in its Middle to a fleshy Belly, is inserted to the fore-part of all the *Vertebrae* of the Neck: This, with its Partner acting, bends the Neck right forward. Between this and the *Scale-nus* lies the *Rectus Internus Major*.

**LOOF**, or as they usually pronounce it, *Luff*, is a Term used in *Conding* of a Ship: Thus, *Loof up*, is to bid the Steersman keep nearer to the Wind. To *Loof into an Harbour*, is to sail into it, close by the Wind. To *spring the Luff*, is when a Ship that before was going *large* before the Wind, is brought close, or, as they say, *claps* close by the Wind. When a Ship sails upon a Wind, as they say; that is, on a Quarter-Wind; the Word of him that cons to the Steersman, is, *Luff! Keep your Luff! Veer no more! Keep her to! Touch the Wind! Have a care of the Lee-latch*: All which Words signify much the same thing, and bid the Man at Helm to keep the Ship near the Wind. But on the contrary, if the Ship is to go more *Large*, or right before the Wind, the Word is, *Ease the Helm! No near! Bear up!*

*Steady*, is a Word common to both these Ways of Sailing, either *on a Wind*, or *Large*, and signifies that a Man at Helm should keep the Ship straight to her Course, and not let her go in and out, or make *Tarwes*, as they call it.

**LOOF-HOOK**, is a Tackle aboard a Ship, with two Hooks to it, one of which is to hitch into the *Crengle* of the Main and Fore-sail, and the other is to hitch into a certain *Strap*, which is spliced into the *Cheffe-tree*, and so down the Sail. Its Use is to succour the *Tackles* in a large Sail, that all the Stress may not bear upon the *Tack*. Sometimes also 'tis used when the *Tack* is to be seized the surer.

**LOOF of a Ship**, is that part of her *a-loft*, which lies just before the *Cheffe-trees*; and hence the Guns that lie here are called her *Loof-Pieces*.

**LOOF-TACKLE**, or *Luff-Tackle*, is a small Tackle in a Ship, serving to lift all small Weights in or out of a Ship.

**LOOME**: If a Ship appears big at Sea, when seen at a Distance, they say, she *loomes*, or appears a great Sail.

**LOOME-GALE**, is a gentle easy Gale, or Wind, in which a Ship can carry her Top-sails *a-trip*: see *Trip*.

**LOOP**, in the Iron Works at the Forge, is the Term for about  $\frac{3}{4}$  of C. lb. of Iron which is melted and broken off from a Sow in the Fire of the *Finery*, and at last is brought into a *Bloom*. This Work they call *Shingling the Loop*.

**LOOP-HOLES**, are Holes made in the Cornings of the Hatches of Ships, and in their Bulkheads, to fire Muskets thro' in a close Fight; and the same are they in the covert Defences of all Fortifications.

**LOPHIA**, a Term in Anatomy, for the upper Part of the *Cervix*, or back Part of a Human Neck.

**LOQUELA *sine die***, was formerly the Term for an Inparlance or a Respite in Law; or for a Demur to an Indefinite Time.

**LORD**, by the Writers of the Law, is divided into *Lord Paramount* and *Lord Mesne*.

*Lord*



*Lord Mefne*, is he that is Owner of a Manor, and by virtue thereof hath Tenants holding of him in Fee, and by a Copy of Court-Roll, and yet holdeth himself of a superior Lord, called *Lord Paramount*. Also he is called *Lord in Grofs*; that is, a Lord having no Manor, as the King in respect of his Crown: And there is a Case wherein a private Man is *Lord in Grofs*; as when a Man makes a Gift in Tail of all the Land he hath, to hold of him, and dieth, his Heir hath but a *Seigniorie in Grofs*.

**LORDOSIS**, by some Writers, is the Term for the bending of the Back-bone forwards in Children, &c.

**LOT**, or *Lothe*, is every thirteenth Dish of Lead in the *Derbyshire* Mine, which is a Duty paid to the King.

**LOTION**, a Term used by some Chymists and Pharmacal Writers, signifying only the washing of any Medicine in Water. Some also call Remedies which are between a *Fomentation* and a *Bath*, and which are used to wash the Head, or any Part affected, by this Name of *Lotion*.

**LOTION** of the Philosophers [in Chymistry] is a Cohobation which Nature makes of what is rais'd up, and afterwards falls back to the Bottom of the Vessel.

**LOURGULARY**, is a Word in *Statuto pro Stratis*, Lond. printed A. D. 1573. Art. 43; and then signified, casting any corrupt Thing into it to spoil or poison the Water.

**LOWER Flank**, or *Retir'd Flank*; see *Flank*. A Term in Fortification.

**LOXODROMIQUES**,  $\lambda\omicron\chi\omicron\delta\rho\omicron\mu\iota\alpha$ , of  $\lambda\omicron\chi\omicron$  **LOXODROMY**,  $\lambda\omicron\chi\omicron\delta\rho\omicron\mu\omicron$ , Gr. *a Course*,] is the Art or Way of oblique Sailing by the *Rhumb*, which always makes an equal Angle with every Meridian; i. e. when you sail neither directly under the Equator, nor under one and the same Meridian, but obliquely or across them. Hence the Table of Rhumbs, or the Traverse-Table of Miles, with the Difference of Longitudes and Latitudes, by which the Sailor may practically find his Course, Distance, Latitude or Longitude, is by Sir J. Moore, and others, called by this Name of *Loxodromiques*; and such Tables as serve truly and expeditiously to find the several Requisites, or resolve the Cases of Sailing, are called *Loxodromical Tables*.

**LOZENGE**, is that Figure in Heraldry which the Geometers call a *Rhombus*; i. e. a Parallelogram, whose Angles are oblique, but Sides all equal; and the Distance between the two obtuse Angles always equal to the Length of one of the Sides. Thus,



In which it differs from the *Fusil*; which see.

In this Figure all unmarried Gentlewomen and Widows do bear their Coats of Arms; because, as some say, 'twas the Figure of the *Amazonian Shield*; or, as others, because 'tis the ancient Figure of the *Spindle*.

**LUCID Intervals** [with Physicians] the Fits or Paroxysms of *Maniacs*, in which the Frenzy leaves them in possession of their Reason.

**LUCIDA Corona**, a Fixed Star of the Second Magnitude, in the *Northern Garland*; whose Longitude is 217 Deg. 38 Min. Latitude 44 Deg. 23 Min. *Right Ascension* 230 Deg. 12 Min.

**LUCIDA Hydra**: see *Cor Hydra*.

**LUCIDA Lyra**, a bright Star of the first Magnitude, in the Constellation *Lyra*; whose Longitude is 10 Deg. 43 Min. Latitude 61 Deg. 47 Min. *Right Ascension* 276 Deg. 27 Min. and *Declination* 38 Deg. 30 Min.

**LUCIFEROUS**, that which brings Light; a Word used by my Lord *Bacon*, and some other Naturalists, for such Experiments in Philosophy as do not so much enrich a Man, as inform and enlighten his Mind about some Physiological Truth, or Speculation in Physicks.

**LUCRATIVE Interest**, in the Civil Law, is such as is paid where there hath been no Advantage made by the Debtor, and no Delay nor Deceit in him. This is condemned by both the Civil and Canon Law.

**LUES Venerea**, *Morbus Gallicus*, the *French Pox*, is a malignant and contagious Distemper, communicated from one to another by Coition, or other impure Contact, proceeding from virulent Matter, and accompanied with many ill Symptoms, such as *Gonorrhæa's*, with the falling off of the Hair, Spots, Swellings, Ulcers, Pains in the Bones, &c.

**LUES Deifica**: see *Caducus Morbus*.

**LUFF**, a Sea Term; the same with *Loof*: Which see.

**LUMBAGO**, is a Pain in the Muscles of the Loins, which *Blanchard* takes to be clogged with scorbutick Matter; so that the Patient is forced to stand upright, being not able to sit down without great Pain.

**LUMBALES Musculi**: See *Psoas Magnus*.

**LUMBARIS Vena**, a Vein arising from the descending Trunk of the *Cava*, and is not always one, but often two or three on each side, which they divide into the *Lumbaris Superior* and *Inferior*; they are bestowed on the Muscles of the Loins, and on the *Peritonæum*.

**LUMBARY Arteries**, are by some said to come from the *Aorta*, unto all the Parts of the Loins, and to the Marrow of the Back-bone; sending as many Branches to its Joints, as there are Holes in it.

**LUMBRICAL Muscles**, are with some Anatomists, those four Muscles which serve to move the Fingers or Toes, and are so called from their Worm-like Form.

**LUMBRICALES**, seu *Vermiculares*, are Muscles of the Fingers, so called from their Figure, being not much unlike the common Earth-Worms; they are also called *Flexores primi internodii digitorum*, from their Use. These probably perform those minute Motions of the Fingers, when the second and third Internodes are curvated by the two last treated of Muscles; and therefore used in playing on Musical Instruments, and may be thence named *Musculi Fidicinales*.

**LUMBRICALIS Pedis**, is a Muscle of the lesser Toes, springing from the internal Part of the *Os Calcis*; and becoming tendinous, joins with the Tendons of the *Perforans* in the middle of the Sole of the Foot; then dividing itself into four (as it were) distinct fleshy Muscles, they all become tendinous at their Insertions to the internal Parts of each lesser Toe, laterally, next the Great Toe.

**LUMINARIES**. The *Sun* and *Moon* are so called by way of Eminence, for their extraordinary Lustre, and the great Proportion of Light that they afford us.

**LUNA Cornea**, is a tough insipid Mass, almost like Horn, made by pouring warily on Crystals of Silver (which Crystals were made by dissolving that



that Metal in good Aqua-fortis or Spirit of Nitre) either Spirit of Salt, or a strong Brine made of common Salt and Water. The Mixture is dried, and then brought to Fusion in a Crucible, or a Glass Phial; where, after it hath been kept a little while so, it turns into this Shape, which the Chymists call *Corned Luna*.

In which Process, 'tis very remarkable, that tho' a Solution of Silver be commonly one of the worst of Bitters, and Spirit of Salt have a very sour and acid Taste, yet the Union of these together, produces a Body perfectly insipid; which plainly shews that Tastes depend on Mechanical Principles, and are various, according to the various Textures of Bodies.

LUNARY Months, are either Periodical, Synodical, or Illuminative; which see in their proper Places.

LUNAR Cycle: see Cycle of the Moon.

LUNATICK [*Lunatici* of Luna, L. the Moon] affected or governed by the Moon: Hence mad People are called *Lunatics*, because the Antients were of Opinion, that such Persons were much influenced by that Planet.

LUNATIONS of the Moon, are the Times between one New Moon and another: And this is greater than the Periodical Month by two Days and five Hours; and is called the *Synodical Month*, consisting of 29 Days, 12 Hours, and  $\frac{1}{2}$  of an Hour.

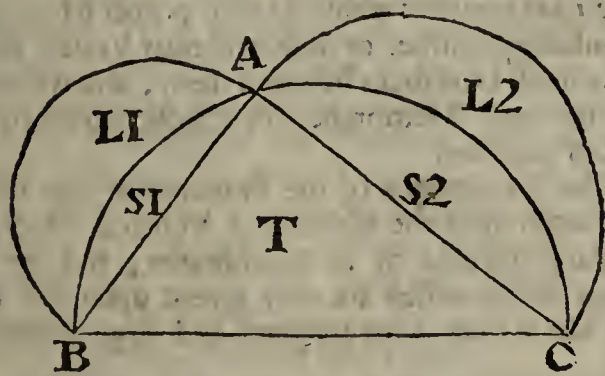
LUNDRESS, did formerly signify a Silver Penny, or a *Sterling* or *Easterling* in a restrained Sense, and was so called, because coined only at London, and not at the Country Mints.

LUNE or *Lunula*. In *Phil. Trans.* N<sup>o</sup> 265. you have a Way to find the Dimensions of the Solids, which will be formed by the Revolution of the *Lunes* of Hippocrates of Scio, by Mr. *Abr. de Moivre*.

LUNES, or *Lunula*, in Geometry, are Figures in the Form of a Crescent or Half-moon, made by the Arks of two intersecting Circles; as in the following Figures the Space *L* is called a *Lune*.

### PROPOSITION I.

#### 1. The Quadrature of Hippocrates his Lunes.



I say, The Triangle *T*, is equal to the two *Lunes* *L* 1, and *L* 2.

### DEMONSTRATION.

The Semi-circle on *BC*, is equal to the Semi-circles on *BA* and *CA*.

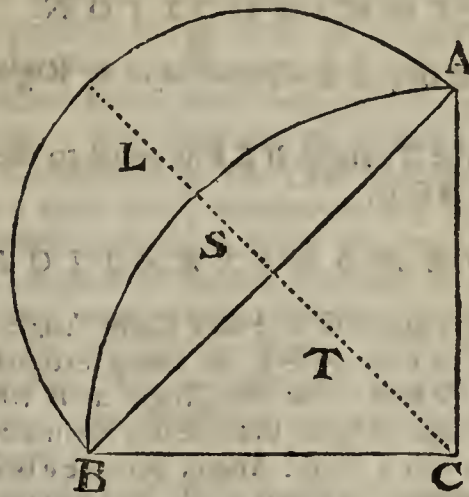
And the Segments, *S* 1 and *S* 2, are common to all the three Semi-circles: Which being taken from the greater Semi-circle, they leave the Triangle *T*; and taken from the two lesser Semi-circles, they leave the two *Lunes* *L* 1 and *L* 2.

Therefore the Triangle *T* = to both the *Lunes*.

Q. E. D.

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#### 2. Otherwise in a Quadrant.



I say, the Triangle *T*, is equal to the *Lune* *L*.

### DEMONSTRATION.

The Triangle *T* being Quadrantal and Isoscelar, it must be that  $AB^2 = 2BC^2$ .

But  $2BC^2 = \frac{1}{2}$  Square of  $2BC = \frac{1}{2}$  the Square of the Diameter of the greater Circle; that is, the Square of the Diameter of the greater Circle, is double the Square of the Diameter of the lesser Circle *AB*.

Therefore the Semi-circle on  $2BC =$  twice the Semi-circle *BLA*; and consequently the Quadrant  $ABC =$  Semi-circle *BLA*.

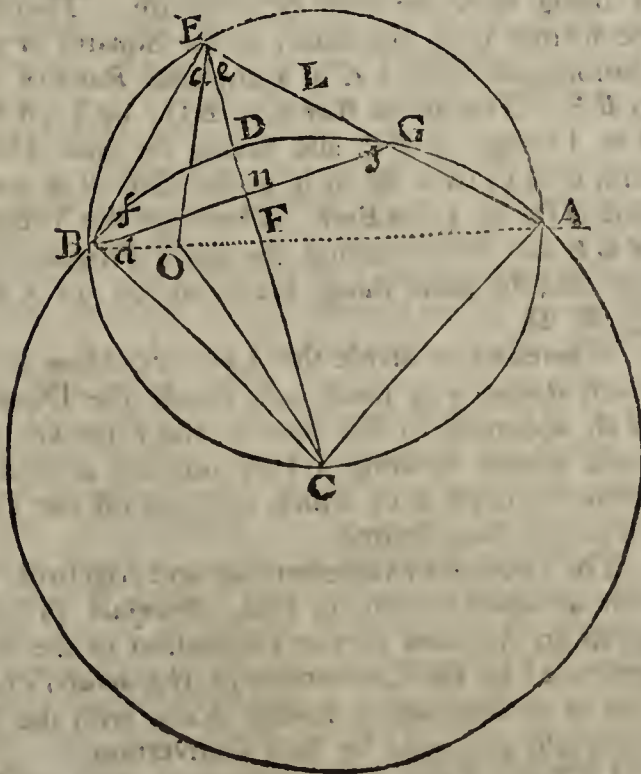
Take therefore from each the common Segment *S*; and there remains the *Lune* *L* = to the Triangle *T*. Q. E. D.

#### 3. To square the Half of the Lune *L*.

'Tis certain, that a Right Line drawn from *C* thro' the Center of the lesser Circle, must divide both Triangle, Segment, and *Lune* into two equal Parts, and consequently  $\frac{1}{2}T = \frac{1}{2}L$ : And thus the Half-*Lune* is squared.

#### 4. To square any Part less or greater than Half the Lune.

Let there be a Quadrant, as before, *BAC*, and a *Lune*, as *L*: 'Tis required to find the Segment of the *Lune* *BED*, made by the Line *EC* drawn to the Center of the greater Circle; which *Pardie* saith, is as difficult as squaring the Circle. *Lib.* 6. *Art.* 64.





## C O N S T R U C T I O N .

Draw  $EB$  and  $EA$ , and  $BG$  at Right Angles with  $EC$ .

I say, the Triangle  $BEF$  is equal to the Part of the *Lune*  $BED$ .

## D E M O N S T R A T I O N .

1. The Angle at  $G = \frac{1}{2}$  of a Right Angle, because 'tis equal to  $o + a + f$ , as being external to the Triangle  $GEB$ : But the Angle at  $E$  (or  $a + o$ )  $=$  to a Right Angle, because in a Semi-circle; and  $f$  must be half a Right Angle, because  $o$  being in the same Segment, is equal to  $d$ , and consequently is half a Right Angle; wherefore  $g$  also must be half a Right Angle (because  $n$  is a Right Angle by Construction) and consequently  $f$  must be half a Right Angle: Wherefore the Right Angle at  $E$ , and the Right Line  $BG$ , and also the Segment  $BDG$ , are all bisected.

2. Also the three Triangles,  $GEB$ ,  $EGF$ , and  $EFR$ , are Isoscelar and Rectangled; therefore each one must be the half of a Square.

3. Therefore  $GB : EB :: \sqrt{2} : \sqrt{1}$ , because the Square of  $GB =$  twice the Square of  $EB$ .

4. Consequently the Segment on  $GB$ , to that on  $EB :: 2 : 1$ , because they are similar Segments.

5. Therefore  $\frac{1}{2}$  of one ( $DBF$ )  $=$  the whole other  $EB$ ; which being taken from the Triangle, and added to the *Lune*, the whole must be equal.

And therefore the Triangle  $BEF$  is equal to the part of the *Lune*. *Q. E. D.*

The Ground of all which is this, That the Angle  $BCE$  being at the Center of one Circle, and at the Circumference of the other, the Line  $EDC$  must divide the Quadrantal Ark  $AGB$  in the same Proportion as it doth the Semi-circular one  $BEA$ : Whence follows the Equality of the Segments  $BE$  and  $BDF$ , on which all depends.

6. And since the  $\triangle BCA =$  to the whole *Lune*  $BEAGB$  by N. 3. 'Tis easy to take thence a Part (as the Triangle  $BOC$ ) equal to the assigned Portion of the *Lune*. For having let fall a Perpendicular from  $E$ , to find the Point  $O$ , draw  $OC$ . I say, the Triangle  $BOC =$  to  $\triangle BEF$ , and consequently to the Segment of the *Lune*  $EBD$ .

For the Triangle  $BCA$  and  $BEF$  are similar, as being each the Half of a Square. Therefore the former is to the latter, as the Squares of their homologous Sides, *i. e.* in a duplicate Ratio of  $BA$  to  $BE$ . That is, as  $BA$  is to  $BO$ ; by 8 *e.* 6 *Euc.* The Triangle  $ABC$ , also having the same Height with  $BOC$ , will be to it as the Base  $BA$  to the Base  $AO$ , by 1 *e.* 6 *Euc.* Wherefore the Triangles  $AEF$  and  $BOC$  having the same Proportion to one and the same thing, are equal, by 9 *e.* 5 *Euc.* *Q. E. D.*

Wherefore to divide the *Lune* according to any given Ratio, you need only divide the Diameter  $AB$ , according to that Ratio in the Point  $O$ : And from thence erecting a Perpendicular to find the Point  $E$ , draw  $EC$ , which shall cut off the Portion of the *Lune* desired.

The excellent Mathematician and Algebrist, Mr. *Abr. de Moivre*, hath, in *Philos. Transact.* N<sup>o</sup> 265, given an Account of the Dimension of the Solids generated by the Conversion of *Hippocrates's Lune*, and of its Parts about several Axes, with the Surfaces also generated by such Conversion.

LUNETTES, in Fortification, are *Evelopes*, *Counter-gardes*, or Mounts of Earth cast up before

the Curtain, about five Fathom in Breadth, whereof the Parapet takes up three. They are usually made in Ditches full of Water, and serve to the same purpose as *Falſe Braies*. These *Lunettes* are compos'd of two Faces, which form a Re-entring Angle; and their Platform being only twelve Foot wide, is a little raised above the Level of the Water, and hath a Parapet three Fathom thick.

LUNGS. These Organs of Respiration are seated in the middle of the Cavity of the *Thorax*; and divided into two Lobes by the *Mediastinum*; of which, the left is ordinarily subdivided into two more. The Figure of both Lobes together resemble the Foot of an Ox or Cow, being a little concave between the two Lobes; where they embrace the Heart; and behind, where they lie upon the *Vertebrae*: But before, where they touch the *Sternum* and *Ribs*, they are convex.

The Colour of the Lungs in a *Fœtus* is of a pale Red; but after the Air hath once entred into them, they lose their Red, and remain always pale; yet in adult Persons, they are often variegated with the one and the other.

They are tied to the *Sternum* by the *Mediastinum* before; and to the *Vertebrae* by the *Plura* behind, when it rises from the *Vertebrae* to the Heart, by the *Vena* and *Arteria Pulmonaris*; and sometimes to the *Pleura*, where it covers the *Ribs*, particularly in the left Side, and especially after a *Pleurisy*.

The Lobes of the Lungs are covered with a double Membrane; of which the external is a Production of the *Pleura*: and the internal, not only covers immediately the Substance of the Lungs, but its inner *Lamina* fill up the Interstices which are below the Bunches of the small Lobes with little vesicular Cells: The fine Capillary Blood-Vessels are so thick upon this Membrane, that it seems to be nothing but a Net-work of Veins and Arteries.

The Substance of the Lungs is compos'd of an infinite Number of little Lobes of various Figures and Magnitudes; but their Surfaces are so adapted to one another, as to leave but very few, and those small Interstices.

These Lobes are disposed like so many Bunches of Grapes upon the Sides of the *Bronchia*. Each little Lobe contains within its own proper Membrane an infinite Number of little orbicular Vessels, which leave small Interstices between them; and which are full of small Membranes, like those which tie the Lobes together.

The Extremities of the Branches of the Wind-pipe open into the Cavities of Vesicles, which are probably formed by its Membranes; but the Capillary Blood-vessels are only spread upon the Vesicles like a Net, with frequent and large Inosculation.

The Vessels which enter the Lungs are the *Trachæa* or *Aspera Arteria*, by which we draw in and expire Air: And the *Arteria Pulmonalis*, which comes from the *Right Ventricle*, and the *Vena Pulmonalis*, whose Trunk opens into the left *Auricle* of the Heart: Each of these divides into two Branches, for the two great Lobes of the Lungs, where they are subdivided into as many Branches as there are little Lobes or Vesicles in the Lungs. Wherever there is a Branch of the *Trachæa*, there is also a Branch of the Vein and Artery, and the *Trachæa* is always in the middle.

On the Branches of the *Trachæa* (which they call the *Bronchi* or *Bronchia*) runs a small Artery called by *Ruyſh*, *Arteria Bronchialis*; and a small Vein, which *Somnichellius* calls *Vena Pneumonica*: The Artery comes from the *Aorta*, the Vein from the *Subclavian*.



The Blood in the *Arteria Pulmonalis* being of the Nature of Venal Blood, and all Secretion being performed in the Arteries, the Nourishment for the Lungs must be brought by the *Arteria Bronchialis*: And there is the same Contrivance for the Nourishment of the Liver.

Upon the *Bronchia*, even to their minutest Ramifications, run likewise the fine Thread of the eight Pair of Nerves.

Besides these, the Lungs have also *Lymphaticks*, which discharge themselves into the *Thoracick Duct*; but they are smaller, and make more frequent Inosculation, almost than any other.

This is the Passage of the Vessels thro' the Lungs; but because the *Trachæa* hath a particular Structure, it demands a particular Examination.

The *Trachæa* then, or *Aspera Arteria*, is a Canal situated in the first part of the Neck, before the *Oesophagus*; its upper End is called *Larynx*, from whence it descends to the 4th *Vertebra* of the Back; where it divides and enters the Lungs; this Canal is made of annular Cartilages, at small and equal Distances from one another: And these grow smaller still as they approach the Lungs; and those of the *Bronchi* are so close to one another, that in Expiration the second enters with the first, and the third with the second, and so the following always enters into the preceeding.

Betwixt the *Larynx* and the *Lungs*, these Cartilages make not compleat Rings; but their hinder Part, which is contiguous to the *Oesophagus*, is membranous, that they may the better contract, dilate, and give way to the Aliments, as they go down the *Oesophagus*. But the Cartilages of the *Bronchi* are compleatly annular; yet their Capillary Branches have no Cartilages; but instead of them small circular Ligaments, which are at pretty large Distances from one another. The use of the Cartilages is to keep the Passage for the Air always open; but in the Capillary *Bronchi*, they would hinder the subsiding of the Vessels.

These Cartilages are tied together by two Membranes, the one *External* the other *Internal*. The *External* is composed of circular Fibres, and covers the whole *Trachæa* externally. The *Internal* is of exquisite Sense, and it covers the Cartilages internally. It is composed of three distinct Membranes: The first is woven of two Orders of Fibres; those of the first of which are *Longitudinal*, for the shortning of the *Trachæa*, and these make the Cartilages approach to and enter one another. The other Order is of circular Fibres, for the contracting the Cartilages. When these two Orders of Fibres act, they help, with the *External* Membrane, in Expiration, in Coughing, and in altering the Tone and Notes of our Voice.

The second Membrane is altogether glandulous, and the excretory Vessels of those Glands open into the Cavity of the *Trachæa*, in order to moisten its Cavity by a Liquor which they separate; and to defend it from the Acrimony of the Air.

The third and last Membrane is a Net-work of Veins, Arteries and Nerves: The Veins are Branches of the *Cava*; the Arteries of the *Carotides*; and the Nerves of the *Recurrent*.

From the Structure of the Lungs thus described, Dr. *Pitcairn* hath deduced mechanically the great Effect they by means of the Air produce upon the Blood. For while the *Fœtus* is in the Womb, the Vesicles of the Lungs lying flat one upon another, compress all the Capillary Blood-vessels which are spread upon them; but as soon as it is born, and alive, the Air rushes into the empty Branches

of the *Trachæa*, and blows up the Vesicles into their Spherical Figures; by which Means, the Pressure or Compression being taken off from the Blood-vessels, and they equally expanded with the Lungs, all the Blood hath a free Passage thro' the *Pulmonary Artery*. But when the Air is thrust out again by the Contraction of the Cavity of the *Thorax*, it being a fluid Body, compresses the Vesicles and Blood-vessels upon them every where equally. By which Compression the red Globules of the Blood, which thro' their languid Motion in the Veins, were grown too dry to circulate in the fine Capillary Vessels, are broken and divided again in the Serum, and the Blood made fit for Nutrition and Secretion.

This Pressure of the Air upon the Blood-vessels, Dr. *Keill* saith, he hath demonstrated to be equal to 100 lb. Weight; and in Coughing or Crying, it may exceed 400 lb.

But tho' these are the necessary Consequents of Respiration, yet several Experiments incline him to think, that some Particles of the Air must likewise enter the Blood-vessels, and mix with the Blood in the Lungs.

For, first, he saith he is assured, from repeated Experiments, that Air will escape the Pores of any Number of Bladders, when compressed only by the Weight of the Water into which it is sunk; and therefore the Pressure of 100 lb. Weight in ordinary Respiration, must thrust some Particles of it into the Blood-vessels.

2. The honourable Mr. *Boyle*, in his *New Pneumatical Experiments*, shews us, That Animals cannot live when shut up in common Air, tho' by a Gauge he hath found it to retain its wonted Pressure; and tho' the Receiver hath been immersed in Water cooled with a Solution of *Sal Armoniac*. The same Experiments assure us, That Animals will live longer when shut up in compressed Air, than in common Air; and that when they are dying in the common Air, they may be revived by pressing in more fresh Air.

3. It may be demonstrated, (saith the same Dr. *Keill*) That the Difference between the Gravity of the Air in the City, and that of the Country, (which can be but very small, upon the Account of the *Effluvia*, as the *Barometer* shews it to be) can never be the Cause of that Difficulty of Breathing, which some have in the one and not in the other; for they are not near so sensible of the different Gravities of the Air in the same Place, as they are of a much smaller Difference in two distinct and remote Places, where the Contents of the Air are different.

The Lungs are composed of an infinite Number of little Lobes, of different Figures and Magnitudes, but yet so joined, as to leave but small Vacuities behind them. Each Lobe consists of an Infinity of small *Spherical Vesiculæ* formed by the Coats of the small Branches of the *Trachæa*; so that they may be considered, when blown up, as so many fine Tubes ending in fine hollow Spheres. On the Sides of these *Vesiculæ*, the Blood-vessels are spread in a fine Net-work: But before the *Fœtus* is brought to light, these *Vesiculæ* lie flat on one another, and by their Pressure on the Blood-vessels, hinder its Passage thro' them; but as soon as the *Fœtus* enjoys the Benefit of the Air, that doth, by its Weight and elastick Force, rush in thro' the Pipes of the *Trachæa* into these *Vesiculæ*, and blows them up; whereby they stand erect on the Trunks of those like *Wind-pipes*, and give a free Passage to the Blood thro' these Vessels spread upon their Sides. And when



when by the Weight of the *Thorax*, and the Acts of its Muscles, together with those of the *Abdomen* and *Diaphragma*, this Elastick Fluid, the Air, is thrust out of those *Vesiculæ* thro' the *Trachæa* in Expiration, these *Vesiculæ* pressing one against another, and the elastick Fluid acting on their Sides, and consequently on the Blood-vessels thereon spread, separate the Globules of the Blood from one another, render it more capable of Circulation in the narrow Passages of the Capillary Vessels.

And there seems to be a yet more considerable Use of this *Natural Function* behind; which is, to form those Elastick Globules, of which the Blood principally consists. It is undoubted Fact and Observation, that the Blood consists of a *Lympha*, which is the common Vehicle, several Salts, *Ramenta* of a thick Consistence (which is probably the unformed Part of the Chyle and Aliment) and these Globules of which we are now speaking, tho' sometimes they are of different Colours, as *White, Blue, Purple*. This any one may discover with an ordinary Microscope. Now 'tis certain that these Globules may be *burst*, as in Obstructions; and all *exhausted*, as in violent *Hæmorrhages*; and yet be all recovered and recruited again; wherefore they must be *formed* somewhere in the Body, from the Chyle. And since 'tis certain that they are not *solid* Particles, as appears both by ocular Inspection and Truth; also that they do actually change their Globular Figures in those of *oblong Sphæroides*, as they move thro' the Capillary Vessels; as therefore from their *Colour*, and from their being coagulated by Acids, and having their Figures destroyed; it is highly probable, that they may be little Bubbles blown from the viscid Part of the Chyle, by the Force of some more subtle elastick *Aura*. Now no Place in the Body can afford this elastick Fluid, but the Lungs; and this may be the Reason why the Chyle enters into those two *Veins* only, which are just returning into the Heart immediately to be sent into the Lungs. For since in our gross Element of Air, there is always lodged a finer elastick Fluid, which is the principal Agent in all the subtle Effects commonly ascribed to the other: tho' the grosser Element cannot, yet this finer Fluid, (by the vast Force used in Expiration) may be thrust in thro' the Sides of these *Vesiculæ*, to the Blood-vessels. And since these Blood Globules must be generated somewhere, and that there is no Place in the Body this subtle elastick Fluid can be squeez'd thro' with sufficient Force to get into the Blood thro' the Sides of the Blood-vessels, but in the Lungs; 'tis very probable these Globules are there formed after this manner. The viscous Part of the Chyle being by the shortest and safest Course possible brought into the returning Part of the Blood, is sent from the *right Ventricle* of the Heart to the Lungs, and is spread upon the Sides of the *Vesiculæ* thereof in little fine Tubes: This fine fluid Elastick being squeezed, in the Act of Expiration, thro' a Pore, continued thro' the *Vesicle* of the Lungs and the Side of the Blood-vessels, is forced into the viscous Part of the Chyle now running by in the *Serum*, and by its perpendicular *Pressure* on the Sides of that Cavity it forms, produces a little small Bubble, of a determinate Magnitude and Thickness of Shell, from whence it hath its Colour: After this, by the Force of the succeeding Fluid, this little Bubble is broken off from the Pore, and carried along the Artery; and the Cohesion of the Parts of the Shell of this Bubble being greater than the Force from without, whereby the thin *Serum* acts upon it, it is preserved in its Figure in all the various Motions of the com-

pound Fluid of the Blood. And if it happen that these little Bubbles should be burst (as they most certainly are by 1000 Causes) whenever they come to the Lungs they are new formed again; whereby the Circulation is render'd constant and uniform. For should these Bubbles be all destroyed, there must of necessity rise a general Obstruction in all the Capillary Arteries. An Instance of the Formation of such kind of little Bubbles, a Mixture of Oil and Vinegar affords; for that look'd on thro' a Microscope, appears to be nothing but an Infinity of such like little Bubbles, formed by the Immission of the Air and Vinegar into little Shells of Oil. *Vid. Cheyne's Phil. Princip. of Natural Religion*, p. 214.

LUNI-SOLAR Year, in Chronology, is a Period made by multiplying the Cycle of the Moon (or 19) into that of the Sun, which is 28; which is 532: and in this Space of Time, 'twas thought the Sun and Moon would come to be together again exactly.

LUNULÆ, the same with *Lunes*; which see.

LUPIA, is a Tumor, or Protuberance, about as big as a small sort of Bean; some take it for a *Meliceris*, others for a *Ganglio*. *Blanchard*.

LUPUS, a Southern Constellation, consisting of two Stars.

LUPUS, a sort of Canker in the Thighs and Legs. *Blanchard*.

LUSHBURG, } was a base Sort of Coin used

LUSHBOROW, } in the Days of King *Edw. III.* which was coined beyond Sea to counterfeit the *English* Money; wherefore by a Statute in 25 *Edw. 3. c. 2.* it was made Treason for any one designedly to bring them into the Kingdom.

LUST; if a Ship *heel* either to *Starboard* or *Port*, the Seamen say that she hath a *Lust* that way; and they say so, tho' it be occasional only by the *Shooting* of her Ballast, or by the unequal *stowing* of Things in her *Hold*. Tho' 'tis more properly said of a Ship, when she is inclined to *heel* any way, upon the Account of her *Mold* or *Make*.

LUTATION, is a cementing of Chymical Vessels close together.

LUTE (in Chymistry) is that wherewith the Chymists join together the Necks of the Retorts and Receivers, or wherewith they coat over the Bodies of Glass Retorts, to save them from being melted in very violent Fires.

The following Composition *Lemery* commends as good *Lute*. Take of Sand, Drois of Iron and Potter's Earth in Powder, of each five Pounds; Horsedung cut small, a Pound; powdered Glass and Sea-salt, of each four Ounces. Temper all these well with Water, and then with the Paste coat the Retorts as far as to half the Neck; or use it to *lute* together (as they call it) the Necks of the Retorts and Receivers. When 'tis dry, 'twill be exceeding hard; and therefore when you would separate the Vessels, you must wet it first well with exceeding wet Cloths.

The *Lute* which *Lemery* used himself, was only two parts of Sand, and one of Clay, tempered together in Water: Which will do very well to join the Noses of Retorts, and their Receivers in the Distillation of Volatile Spirits, &c. When you distil by the Alembick, or *Vesica*, or Copper Body, with its Head and Serpentine, a wet Bladder will serve very well to *lute* the Junctures of the Vessels. But when corroding Spirits are to be distilled, 'twill be better to use the following *Lute*: Take fine Flower, Slak'd-lime, of each an Ounce; Potter's-Earth, or Powder of Pots, half an Ounce. Make a moist Paste



Paste of these with Whites of Eggs, well beaten before with a little Water, and this will stop exceeding close. N. B. This may be very well used to stop the Cracks that will often happen in Glass Vessels; and there must be three Lays of the Paste bound on with Paper.

Mr. Boyle recommends on Experience for this last Purpose, the following Composition, viz. Good Quick-lime and Scrapings of Cheese pounded in a Mortar, with as much Water as will just bring the Mixture to a soft Paste; then spread it on a Piece of Cloth, and apply it as Occasion requires.

LUTHERNS [in *Architecture*] Dormers, a kind of Windows over the Cornice in the Roof of a Building, standing perpendicularly over the Naked of the Wall, and serving to enlighten the upper Story.

LUXATION, a Term in Chyrurgery, is the Dislocation, displacing, or putting any Bone or Joint out of its Place.

LUXATOR *Externus*, a Muscle so called: See *Externus Auris*.

LYCANTHROPIA, [*λυκανθρωπία*, of *λύκος*, a Wolf, and *άνθρωπος*, Gr. a Man.] *Rabies Hydrophobica*, a Madness proceeding from the Bite of a mad Wolf, wherein Men imitate the howling of Wolves. *Blanchard*.

LYE *under the Sea*, is the Mariners Term for a Ship, which having her Helm lash'd fast *a-Lee*, lies so *a-Hull*, that the Sea breaks upon its Bow, or Broadside.

LYEF-YELD, or *Leff-Silver*, was formerly a small Fine or pecuniary Composition, paid by the customary Tenant to his Lord, for leave to plow and sow.

LYGMOS, [*λυγμός*, Gr.] the Hickets, is a convulsive Motion of the Nerves, which spreads up and down the Gullet, returning after short Intermissions. It proceeds from some troublesome Matter that vellicates the *Oesophagus*. *Blanchard*.

LYMPHA, [of *λυμή*, Gr.] is a clear limpid Humour, consisting of the Nervous Juice and of Blood; which being continually separated by the Glandules, is at last discharged into the Blood again by Vessels peculiar to it. The *Lympha* comes not immediately from the Blood, or Nervous Juice, as some think, but it is the Superfluity of each; which was more than enough for the Nourishment of a Part, like the Marrow in Bones. It is taken sometimes for that Water which flows from the pricking of Nerves, and other Wounds; and which does not really flow from the Nerves themselves, but from the Lymphatick Vessels which are cut and wounded. *Blanchard*.

LYMPHATICK Vessels: see *Vena Lymphatica*.

LYMPHÆDUCTS, are slender pellucid Tubes, whose Cavities are contracted at small and unequal Distances by two opposite Semi-lunar Valves,

which permit a thin and transparent Liquor to pass through them towards the Heart, but which are shut up like Flood-gates on its returning. They rise in all Parts of the Body, but after what Manner needs no great Dispute; for without doubt all the Liquids in the Body, excepting the Chyle, are separated from the Blood in the fine Capillary Vessels by a different Pipe from the common Channel in which the rest of the Blood runs: But whether this Pipe be longer or no longer than the Thickness of the Coat of the Blood-vessel, whether it be visible or invisible, it is still a Gland, whilst it suffers some Parts of the Blood to pass thro' it, denying a Passage to others. Now the Glands that separate the *Lympha*, are of the smallest kind, being invisible to the finest Microscopes; but their Excretory Ducts, the *Lymphatick Vessels*, unite with one another, and grow larger as they approach the Heart; yet they do not open into one common Chanel, as the Veins do; for sometimes we find two or three more Lymphæducts running one by another, which only communicate by short intermediate Ducts, or which unite and immediately divide again. In their Progress they always touch at one or two conglobate or vesicular Glands, into which they discharge their *Lympha*. Sometimes the whole Lymphæduct opens at several Places into the Glands, and sometimes it sends in only two or three Branches, whilst the main Trunk passes over and joins the Lymphæducts arising from the opposite Side of the Glands, exporting again the *Lympha* to their common Receptacles. The Glands of the *Abdomen*, which receive the Lymphæducts from all the Parts which it contains, as likewise from the lower Extremities, are the *Glandula Inguinales*, *Sacræ*, *Lumbares*, *Mesentericæ*, and *Hepaticæ*; all which send out new Lymphæducts, which pour their *Lympha* into the *Receptaculum Chyli*, as those of the Chest, Head, and Arms, do into the *Ductus Thoracicus*, Jugular and Subclavian Veins. The Design of the Lymphæducts emptying themselves into the conglobate Glands, seems to be, that the slow *Lympha* may receive a new Velocity from the Elastick Compression of the Fibrous Cells of those Glands, whose Fabrick resembles that of the Spleen; and therefore they are improperly called Glands, because they separate no Liquor from the Blood. See *Keill's Anatomy*, p. 52.

LYNX, the same with *Lygmus*.

LYPYRIA, is the Term some Writers give to a kind of Fever attended with an *Erysipelas*, or cholerick Inflammation of the Stomach and Guts; and tho' the inward Parts of the Body feel very hot, yet the outward ones are very cold. *Blanchard*.

LYRA, the *Harp*, a Constellation in the Northern Hemisphere, consisting of 13 Stars.



# M A C

**M.** A numeral Letter, which with the Antients signified a Thousand. **M.** with a Dash at the Top, stood for a Thousand thousand; the Letter **M** [in *Astronomical* Tables, &c.] is us'd to signify Meridional or Southern.

**M.** [in *Physical* Prescriptions] signifies *Manipulus* or Handful, and at the End of a *Recipe* is often set for *Misce*, i. e. mingle, or for *Mixtura*, a Mixture.

**M.** [in *Law*] was antiently the Brand or Stigma of a Person convicted of Murder, who was admitted to have the Benefit of his Clergy. It was burnt on the Brawn of the Left Thumb.

**MACARONICK** } Poetry, a kind *Burlesque*  
**MACARONIAN** } Poetry, consisting of a Jumble of Words in different Languages, with Words of the Vulgar Tongue latiniz'd, and Latin Words moderniz'd.

**MACE-GRIFF**, alias *Macegreffe*, *Machearii*; are such as willingly and knowingly buy or sell stolen Flesh.

**MACHINA** *Boylia*na, Mr. Boyle's Air-pump; which see. So called from that Noble Gentleman, being the first Inventor of that Engine.

**MACHINE**, [of *μηχανή* Gr. *Invention*,] or *Engine*, in Mechanicks, is whatsoever hath Force sufficient either to raise or stop the Motion of a Body. These *Machines* are either *Simple* or *Compound*.

*Simple Machines*, are commonly reckoned to be Six in Number, viz. the *Balance*, *Leaver*, *Pulley*, *Wheel*, *Wedge* and *Screw*. To these might be added the *Inclined Plane*, since 'tis certain that the heaviest Bodies may be lifted up by the means thereof, which otherwise could scarce be moved.

*Compound Machines*, or *Engines*, are innumerable, in regard that they may be made out of the *Simple*, almost after an infinite manner.

*Machine for Building*, is an Assemblage of Pieces of Wood so disposed, as that by Means of Ropes and Pullies, a small Number of Men may raise vast Loads, and lay 'em in their Places; as *Cranes*, &c. 'Tis hard to concieve what *Machines* the Antients must have used to raise those immense Stones found in some of the antique Buildings.

*Hydraulic*, or *Water Machine*, is either used to signify a *Simple Machine*, serving to conduct or raise Water; as a *Sluice Pump*, &c. or several of these acting together, to produce some extraordinary Effect; as the *Machine* of *Marley*; the *Primum Mobile* whereof is an Arm of the River *Siene*, which by its Stream turns several large Wheels, which work the Handles, and these with Pistons raise the Water up into the Pumps, and with other Pistons force it up in Pipes against the Ascent of a Hill to a Reservoir in a Stone Tower, 62 Fathom higher than the River, sufficient to supply *Versailles* with a constant Stream 200 Inches in Diameter.

*Machines of War*. These among the Antients were of three Kinds; the first serving to launch Arrows, as the *Scorpion*: Javelins, as the *Catapulta*; Stones, as the *Balista*; or fiery Darts, as the *Pyroboli*; the second serving to beat down Walls, as the battering *Rams* and

# M A C

*Terebra*; and the third to shelter those who approach'd the Enemies Wall; as the *Tortoise* or *Testudo*, and the Towers of Wood. The *Machines of War* now in Use, consist in Artillery, *Bombs*, *Petards*, &c. Tho' it must be observed, that in Strictness, a *Machine* is something that consists more in Art and Invention, than in the Strength and Solidity of the Materials; and for this reason it is that the Inventors of *Machines* are call'd *Ingenieurs* or Engeneers. The Word comes from the Greek *μηχανή* *Machine*.

**MACROCOSM**, is the whole Universe, in Contradistinction to *Microcosm*; which some will have to express the Lesser World, or the Body of Man.

**MACULA** *Epatica*, is a Spot of a brown or of a sad yellow Colour, about an Hand's Breadth broad, chiefly seizing upon the Groin, the Breast and Back, nay sometimes it covers the whole Body; is attended with a certain slight Asperity of the Skin, which lets fall Scales, or a sort of Dandriff from it, which yet do not stick all together, but are disseminated here and there, and sometimes disappear, sometimes break out again. *Blanchard*.

**MACULÆ** *Solares*; see *Spots in the Sun*.

**MACULÆ** in *Astronomy*, dark Spots, of an irregular changeable Figure, observed in the Face of the Sun; first taken notice of by *Sheiner* in 1611, and afterwards accurately observed by *Gallileus*, *Hevelius*, Mr. *Flamsteed*, *Cassini*, *Kirchi*, &c. Many of these *Maculae* appear to consist of heterogeneous Parts, whereof the darker and more dense are called by *Hevelius*, *Nuclei*, and are encompassed, as it were, with Atmospheres somewhat rarer and less obscure; but the Figure both of the *Nuclei* and entire *Maculae* are variable. In 1644, *Hevelius* observ'd a small thin *Macula*, which in two Days time grew to ten times its Bulk; appearing withal much darker, and with a larger *Nucleus*; and such sudden Mutations are frequent: The *Nucleus*, he observ'd, began to fail sensibly e're the Spot disappeared, and that e'er it quite vanished, broke into four, which in two Days reunited. Some *Maculae* have lasted 2, 3, 10, 15, 20, 30, seldom 40 Days; though *Kirch* observed one in 1681, from April 26, to the 17th of July. The Spots move over the Sun's Disk, with a Motion somewhat smaller near the Limb than near the Centre; that observ'd by *Kirch* was 12 Days visible in the Sun's Disk; for 15 Days more it lay hid behind it; it being their Rule to return to the Limb, whence they departed in 27 Days, sometimes in 28 Days. Lastly it must be observed, that the *Maculae* contract themselves near the Limb, and in the Middle of the Disk appear much larger; those often running into one in the Disk, which in the Limb were separate; that many of them arise in the Middle of the Disk, and many disappear in the same; and that none of them are observed to deviate from their Path near the Horizon; whereas *Hevelius* observing *Mercury* in the Sun, near the Horizon, found him too low; being thrust 27 Seconds beneath his former Path. From these Phænomena we collect,

(1.) That since *Mercury's* Depression below his Path arises from his Parallax, the *Maculae* having no Parallax



Parallax from the Sun, are nearer him than the Planet; but since they are hid behind the Sun three Days longer than they are in the Hemisphere visible to us, it follows also, that they don't adhere to the Surface of the Sun, but are at some Distance from it.

(2.) That since they arise and disappear in the Middle of the Sun's Disk, and undergo various Alterations with regard both to Bulk, Figure and Density; they must be formed *de novo*, and again dissolved about the Sun; and are therefore, in all probability, a kind of *Solar Clouds* formed out of its Exhalations.

(3.) Since then the *Solar Exhalations* rise over his Body; and are suspended at a certain Height from it; it appears from the Laws of *Hydrostatics*, that the Sun must be encompassed with some Fluid to drive those Exhalations upwards; which Fluid must be denser, as it is lower; and rarer, as higher, like our Atmosphere, And since the *Maculae* dissolve and disappear in the very Middle of the Sun's Disk, the Matter thereof, *i. e.* the *Solar Exhalations* must fall back again to the Sun; whence there must arise Changes in the Sun's Atmosphere, and consequently in the Sun it self.

(4.) Since the Revolution of the *Maculae* round the Sun is very regular; and since their Distance from the Sun is very small, 'tis not properly the *Maculae* that move round the Sun; but 'tis himself, together with his Atmosphere, wherein the *Maculae* swim, that in the space of 27 Days moves round its own Axis; and hence it is that the *Maculae*, being viewed obliquely near the Line, appear narrow and oblong.

And Lastly, since the Sun appears with a circular Disk in every Situation, his Figure, as to Sense, must be spherical. Some Authors likewise take notice of *Faculae*, or bright Spots, in the Disk of the Sun, much more lucid than the rest, much larger than the *Maculae*, and very different from them both, as to Figure, Duration, &c. *Hevelius* mentions his seeing a *Facula* in 1634, which took up a third Part of the Sun's Diameter; and adds, that the *Maculae* frequently change into *Faculae*; but the *Faculae* seldom or never into *Maculae*: But *Huygens*, and other great Astronomers, reject the Notion of the *Faculae*; having never seen any thing like them (tho' furnish'd with the best Telescopes) excepting little bright Specks in the dim Clouds which frequently encompass the *Maculae*; and which may be owing to the Refraction of the Sun's Ray's in the rarer Parts of his Atmosphere. And as to that little Inequality observed in the Circumference of the Sun's Disk, which is usually ascribed to the Wavings and Eruptions of the Flames; it seems better accounted for from the tremulous Agitation of the Vapours in our own Atmosphere.

*MACULA Volatica*, is a red or purple Spot here and there in the Skin; which, if it touch any Orifice in the Body, as the Mouth, Nostrils, Eyes, Ears, &c. and pierce so far, it becomes mortal: It is often fatal to Children. *Blanchard*.

*MADRIER*, in Fortification, is a thick Plank arm'd with Plates of Iron, and having a Concavity sufficient to receive the Mouth of the Petard when charged, with which it is applied against a Gate, or any thing else that you design to break down. This Term is also appropriated to certain flat Beams, which are fix'd at the Bottom of a Moat, to support a Wall. There are also *Madriers* lined with Tin, which are cover'd with Earth, to serve as a Defence against artificial Fires.

*MAGAZINE* or *Arsenal*, is the Place in Fortified Towns, &c. where all sorts of Stores are kept, and where Carpenters, Wheel-Wrights, Smiths, &c. are employed in making all Things needful to furnish out a Train of Artillery.

*MAGBOTE*, was formerly a Recompence made in Money, or otherwise, for slaying or murdering one's Kinsman; for sometimes the Corporal Punishments in such Cases due were transmuted into Pecuniary Fines; when the Friend, or Relations of the Party slain, were so content. *Leg. Canuti Regis* T. 1. c. 2.

*MAGDALEONES*, are Pieces of Plaister made up in form of a Cylinder, or long Roll.

*MAGICK*, [Some derive the Word *Magick* and *Magi*, or *Magicians*, from the *Persian* Language, in which it signified a *Priest*, or one who officiated in holy things. Others derive it from *Μέγας* Gr. Great, whence the *Persians* formed their *μαγός* or *μαγοί*; but *Vossius* from *הנה* to meditate. Heb. whence *מהגים*, *Mehagim* meditating, *q. d.* Persons addicted to Meditation,] is a Science which teaches to perform wonderful and surprizing Effects. Originally the Word *Magick* carried with it a very innocent and laudable Meaning; being us'd to signify purely the Study of Wisdom; but in time the Name of *Magick* grew odious, when the *Magicians* engag'd themselves in Astrology, Divination, Sorcery, &c. and was us'd to signify a Science unlawful and scandalous.

*MAGICK-Lanthorn*, an Optick Machine, by means whereof little painted Images are represented to an opposite Wall of a dark Room magnified to any Bigness at Pleasure,

Construction of the *Magic-Lanthorn*. *A B C D*, is a common Tin *Lanthorn*, to which is added a Tube to draw out, *F G*. In *H* is fixed a metallic concave Speculum of a Foot Diameter at most, or four Inches at least; or, in lieu thereof, near the Extremity of the Tube is placed a Convex Lens consisting of a Segment of a small Sphere, its Diameter not exceeding a few Inches. In the Focus of the Concave Speculum, or Lens, is placed a Lamp *L*, within the Tube, where it is soldered to the Sides, being a Portion of a small Sphere, having its Focus about the Distance of three Inches. The extream Part of the Tube *F M*, is Square, and has an Aperture quite through; so as to receive an Oblong Frame *N O*, passed through it; in this Frame are round Holes an Inch or two in Diameter. According to the Bigness of those Holes are drawn Circles on a plain thin Glass; and in these Circles are painted any Figures or Images at pleasure, with transparent Water Colours. These Images, fitted into the Frame, and placed invertedly, at a little Distance from the Focus of the Lens *I*, will be projected on an opposite Wall of a dark Room, prodigiously magnified in all their Colours, and an erect Scituation,

*Theory of the Magic Lanthorn*. The Lamp being placed in the Focus of the Concave Speculum, or any Convex Glass, the Rays will be propagated parallel to each other, and the Image will be strongly illuminated, and will therefore emit a great Number of Rays into the Lens *I*. But being supposed to be placed near the Lens *I*, the inverted Image of the Picture inverted must be formed on the opposite Wall, exceedingly magnified after its Refraction through the Lens; and it will be still the more magnified as the Lens is a Segment of a less Sphere, and as the Picture is placed nearer the Focus of the Lens; in a dark place therefore the Picture



ture will be represented prodigiously large and extremely vivid.

Another *Magic Lanthorn*. Every thing being managed as in the former, into the sliding Tube *F G*, insert another Convex Lens *K*, the Segment of a Sphere some what larger than *I*; now if the Picture be brought nearer *I* than to the Distance of the Focus, the diverging Rays will be propagated as if they proceeded from *P*; wherefore if the Lens *K* be so placed, as that *P* is very near its Focus, the Image will be exhibited on the Wall exceedingly magnified.

*Schol.* 1. To heighten the Light, Specula are preferred to Lens's; the Focus of the Speculum being nearer than that of the Lens.

2. *De Chales* orders the Diameter of the Lens *I* to be two, four, or five Digits, and in a subduple Proportion to the other *K*; i. e. if *I* be five Digits, *K* must be 10; and the Diameter of the Speculum, according to the same, is to be two Digits. *Zab-nuis* chuses to have the Diameter of *I*  $\frac{2}{3}$  of a Foot, and that of *K* one Foot and  $\frac{1}{3}$ , &c.

3. Little Animals being included in the *Magic-Lanthorn*, in the manner observed in speaking of the Microscope, or any little transparent Objects fastned to a Slice of Talk or Glass, and substituted instead of Images; the *Magic-Lanthorn* will become a Microscope.

*MAGICK Square*, is when Numbers in Arithmetick Proportion are disposed into such parallel and equal Ranks, as that the Sums of each Row, as well diagonally, as laterally, shall be all equal.

Thus the several Numbers that compose any Square Number; (for Instance 1, 2, 3, 4, 5, 6, 7, 8 and 9, which compose the Square Number 9) being disposed after each other in a Square Figure of 9 Cells, each in its Cell; if then you change the order of those Numbers, and dispose them in the Cells, in such manner, as that the three Numbers which fill any Horizontal Rank of Cells, being added together, shall make the same Sum, with the three Numbers in any other Rank of Cells, whether Horizontal or Vertical; and even the same Number with the three in each of the two Diagonal Ranks, this Disposition of Numbers is called a *Magic Square*, in opposition to the former Disposition, which is called a *Natural Square*.

Suppose it done and represented in its proper Form by the following Symbols thus plac'd, viz.

<i>a</i>	<i>b</i>	<i>c</i>
<i>d</i>	<i>e</i>	<i>f</i>
<i>g</i>	<i>h</i>	<i>i</i>

The Sum of the propos'd Figures is 45; and  $\frac{45}{3} = 15$  is = each Side or Rank = (Suppose) *s*.

Then

1	$a + e + i = s$	} By the Nature of the <i>Quest</i> .
2	$b + e + h = s$	
3	$c + e + g = s$	
1 + 2 + 3	$a + b + c + 3e + i + h + g = 3s$	
	$a + b + c + i + h + g = 2s$ , per <i>Quest</i> .	
4 - 5	$3 = 3s - 2s = s$	
6 ÷ 3	$e = \frac{3}{3} = \frac{15}{3} = 5$ .	

The Value of *e* being thus found to be 5, there remain eight Figures more, viz. 1, 2, 3, 4, 6, 7, 8 and 9; but which of these is equal to any Corner Letter, as suppose *a*, is to be further sought.

Beginning therefore with the least Number 1; I say the Corner Letter *a*, and consequently any Corner Letter, as *c*, *i*, *g*, cannot be equal to it: For, if *a* was = 1, then *i* should be = 9; and  $b + c = 15 - 1 = 14$ , as also =  $d + g$ : But there remain no two Numbers (after 5, 1 and 9) whose Sum is 14 but 6 and 8; therefore, if either of these Figures were = *b*, the other would be = *c*; and then no Figure would remain for the Value of either *d* or *g*: Wherefore *a* is not = 1; neither is *i*, nor, consequently any Corner Letter equal to 1 or 9.

2 may be = *a* as will appear farther on.

3 cannot be = *a*: for, if it were, then *i* should be = 7; and  $b + c = 15 - 3 = 12$ , as also =  $d + g$ : But there remain no two Numbers (after 5, 3 and 7) whose Sum is 12, but 8 and 4, which cannot answer to *b* and *c*, and *d* and *g*; wherefore *a*, or any other Corner Letter is not = 3; neither is *i*, nor consequently any other Corner Letter = 7.

From what hath been said it is plain that (if the *Question* propos'd is capable of being solved) the Corner Letters are all equal to even Numbers; wherefore, placing one of them, as 2 for *a*, *i* will be 8, and *c* must be either equal to 4 or 6; let it (viz. *c*) be = 4; then  $g = 6$ ;  $b = 9$ ;  $d = 7$ ;  $f = 3$ ; and  $h = 1$ : And so the Square is completed as required.

2	9	6
7	5	3
6	1	8

But if *c* were = 6 (*a* being = 2); then  $g = 4$ ;  $b = 7$ ;  $h = 9$ ;  $f = 1$ ; and  $h = 3$ ; and then the Square will stand thus,

2	7	6
9	5	1
4	3	8

&c.

*Quest.* 2. The Numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and 16, being given; it is required to place them in a *Magic Order*, viz. in a Square Form so as counting each Rank whether Horizontal, Perpendicular or Diagonal their Sums may be equal.

Suppose



Suppose it done and represented in its proper Form by the following Symbols thus placed, viz.

$a$	$b$	$c$	$d$
$e$	$f$	$g$	$h$
$i$	$k$	$l$	$m$
$n$	$o$	$p$	$q$

The Sum of the proposed Figures is 136; and  $\frac{136}{4} = 34$  is = each Rank = (Suppose)  $s$ : Then, by the Nature of the *Question*,

$$\begin{array}{ll}
 \therefore e. 1 & 1 \quad a + b + c + d + e + f + g + h = a + e + i + n + b + f + k + n \\
 \text{Also} & 2 \quad c + d + g + h = i + n + k + o \text{ by equal Subtraction.} \\
 & 3 \quad a + b + c + f = l + p + m + q \\
 & 4 \quad a + b + c + d + n + o + p + q = d + g + k + n + a + f + l + q \\
 & 5 \quad b + c + o + p = g + k + f + l \\
 & 6 \quad \text{But the Sum of the two Parts of the 5th Equation is } = 2s; \text{ consequently either Part is } = 1 = 34 \\
 & 7 \quad a + b + c + d + n + o + p + q = a + e + i + n + d + h + m + q \\
 & 8 \quad b + c + o + p = e + i + h + m = s \text{ per } 6^{\circ} \\
 & 9 \quad a + b + c + d + n + o + p + q = b + f + k + o + c + g + l + p \\
 & 10 \quad a + d + n + q = f + k + g + l = s \text{ per } 6^{\circ} \\
 & 11 \quad a + d + n + q = d + h + n + q \\
 & 12 \quad a + n = h + m \\
 & 13 \quad \text{In like manner } d + q = e + i \\
 \text{Also} & 14 \quad n + q = b + c \\
 \text{And} & 15 \quad a + d = o + p \\
 & 16 \quad e + i + h + m = i + k + l + m \text{ per } 8^{\circ} \\
 & 17 \quad e + h = k + l \\
 \text{Also} & 18 \quad c + p = f + k \\
 \text{Also} & 19 \quad b + o = g + l \\
 \text{And} & 20 \quad f + g = i + m \\
 & 21 \quad f + k + g + l = a + f + l + q \text{ per } 6^{\circ} \\
 & 22 \quad k + g = a + q \\
 \text{Also} & 23 \quad f + l = d + n
 \end{array}$$

Having thus far proceeded, and the Question propos'd being (probably capable of a great many different Solutions; it is to be presum'd that  $a$  may be equal to any of the given Numbers: Beginning therefore with the least of them, viz. 1, and putting  $a$  equal it, viz.  $= 1$ , the next Thing to be done is to find the Value of another Corner Letter as  $n$ .

$n$  cannot be equal to 2; for, if it was, then  $h + m$  being (per 12<sup>o</sup>)  $= a + n (= 1 + 2)$  should be  $= 3$ ; but there are no remaining two Numbers of the given ones whose Sum is 3; consequently  $n$  cannot be  $= 2$  ( $a$  being  $= 1$ .)

Neither can  $n$  be equal to 3: For supposing  $n = 3$ , then  $h + m$  being (per 12<sup>o</sup>)  $= a + n (= 1 + 3)$  should be  $= 4$ : But there are no remaining two Numbers of the given ones whose Sum is 4; therefore, &c.

But (for ought can be seen yet)  $n$  may be equal to 4; putting therefore  $n = 4$ ; then  $h + m (= a + n, \text{ per } 12^{\circ} = 1 + 4) = 5$ ; that is  $h, m$  are equal to 2, 3 which are the only two Numbers remaining whose Sum is 5; and therefore  $d + q = 34 - 5 = 29 = c + i$  (per 13); that is  $d, q$ , are equal to 13, 16 or 14, 15; and according  $e, i$  are equal to 14, 15 or 13, 16 only; for no other couple amounts to 29.

Let us see what the Consequence is in putting  $q = 13$ ; then  $d$  is  $= 16$ : And then the Square may be designed, in part, thus

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1	$b$	$c$	16
	$f$		
14, 15			2, 3
	$k$	$l$	
4	$o$	$p$	13

The four Corner Letters being thus design'd; and consequently  $e, i$  equal 15, 14, as also  $h, m$  being equal to 2, 3, it is manifest  $f$  cannot be equal to 5, 6 or 7; for, if it was,  $l$  should be equal to 15, 14 or 13, which are Numbers already dispos'd of: But (perhaps)  $f$  may be, and therefore suppose it,  $= 8$ , and then  $l$  will be  $= 12$ .

Again  $g + k = 14$ ; and there remain no two Numbers whose Sum is 14, only 5 and 9: But  $k + l$  or  $k + 12$  is likewise (per 17<sup>o</sup>)  $= e + h$ , viz. equal to 16 ( $2 + 14$ ), 17 ( $2 + 15$  or  $3 + 14$ ), or 18 ( $3 + 15$ ); consequently  $k$  is equal to 4, 5 or 6 (not equal to 9); and therefore it (viz.  $k$ ) is  $= 5$ .  $k + l (= 5 + 12)$  being thus found  $= 17$  must likewise be  $= e + h$  (per 17<sup>o</sup>), which may be effected two ways; viz. by putting  $e = 15$ , and then  $h$  will be

4 P p

$= 2$ ;



$=2$ ; or, putting  $e=14$ ,  $b$  will be  $=3$ : Let us chuse the former; and then  $i$  will be  $=14$ , and  $m$  will be  $=3$ : And then the Square will be farther designable thus

1	$b$	$c$	16
15	8	9	2
14	5	12	3
4	$o$	$p$	13

It remains to dispose of four Numbers 6, 7, 10 and 11, instead of  $b$ ,  $c$ ,  $o$  and  $p$ , so as  $b+c$  may be  $=17$ , as also  $o+p=17$ , which may be done by coupling 6, 11 also 7 and 10.

But  $c+p$  must be (by  $18^\circ$ )  $=k+f=13$ , which will be effected by  $6+7$ : From whence  $p$  being  $=6$ ,  $c$  will be  $=7$ ; and then  $o=10$ , and consequently  $b=11$ : And then the Square will be fully completed, thus

1	10	7	16
15	8	9	2
14	5	12	3
4	10	7	13

Or, putting  $p=7$ ; then  $c=6$ , then  $o=10$ , and  $b=11$ : And then the Square will stand thus,

1	11	6	16
15	8	9	2
14	5	12	3
4	10	7	13

&c.

MAGISTERY, a Word used by the Chymists, sometimes for *very fine Powders*, made by Solution and Precipitation of the Matter; as *Magistry of Bismuth, Lead, &c.* And sometimes 'tis made to signify *Resins* and *Resinous Extracts*. Thus the Resins of Jalap, Scammony, &c. are called *Magisteries*.

—Mr. Boyle takes the true Notion of a *Magistry* to be a Preparation of Body (not an Analysis of it, for

the Principles are not separated) whereby the whole, or very near the whole of it, by some Additament, is turned into a Body of a different kind; as when Iron or Copper is turned into Crystals of *Mars* or *Venus*, &c.

The canting Alchymists talk also of the *Magistry* of the *Philosopher's Stone*, which will be worth enquiring into, when they will tell us what the Stone itself is. For an Instance how they are made, I will mention two or three.

*Magistry of Bismuth*, is made by dissolving the Bismuth in Spirit of Nitre, and pouring upon it Salt-water, which will precipitate the *Magistry* to the bottom in a white Powder.

*Magistry of Lead*, is made by dissolving *Saccharum Saturni* in distilled Vinegar; and then precipitating it with Oil of Tartar, made *per deliquium*.

*Magistry or Refine of Scammony, Jalap, Turbith, &c.* is made by a Dissolution of the Matter in Spirit of Wine; and then precipitating it by common Water, or Water impregnated with a little Alum. And after these Manners are most other *Magisteries* made.

MAGISTERY of Tartar. See *Tartar Vitriolate*.

MAGMA, signifies the Dregs that are left after the straining of Juices.

MAGNA Arteria [in *Anatomy*] the same with the *Aorta*.

MAGNA Assisa eligenda, is a Writ directed to the Sheriff, to summon four lawful Knights before the Justices of Assize, there upon their Oath to chuse twelve Knights of the Vicinage, &c. to pass upon the Great Assize between A Plaintiff, and B Defendant, &c.

MAGNA Charta, was granted the Ninth Year of Henry the Third, and confirmed by Edward the First. The Reason why it is termed *Magna Charta*, was either for that it contain'd the Sum of all the Liberties of England, or else because there was another Charter, called *Charta de Foresta*, establish'd with it, which was the less of the two; or because it contained more than many other Charters, or more than that of King Henry the First, or of the great and remarkable Solemnity in the denouncing Excommunication, and direful *Anathemas* against the Infringers of it. *Holinshead* tells us, That King John, to appease his Barons, yielded to Laws or Articles of Government, much like to this *Great Charter*; but we have now no ancients Law written than this, which was thought to be so beneficial to the Subject, and a Law of so great Equity, in comparison of those which were formerly in use, that King Henry for the granting of it, had the fifteenth Penny of all the moveable Goods, of both *Temporality* and *Spirituality*.

MAGNESIA Opalina, is a kind of *Crocus Metallorum*, or Liver of Antimony, but of a redder or more Opaline Colour than the common one. 'Tis made after the common manner, with equal Parts of Antimony, Salt-Peter, and Sea-Salt decrepitated. 'Tis less Emetick than the common one, because the Sea-Salt fixes some of the active Sulphurs of the Antimony, and locks them up.

MAGNET, or Loadstone, is a Fossile approaching to the Nature of Iron-Oar, and endowed with the Property of attracting Iron, and of both pointing itself, and also enabling a Needle touch'd upon it, and then poised, to point towards the Poles of the World.

MAGNET. *Sturmius* in his *Epistola Invitatoria Dat. Altorf. 1682*, observes, That the attractive Quality of the Magnet hath been taken Notice of beyond



beyond all History: But that it was our Countryman *Roger Bacon*, who first discovered the *Verticity* of it, or its Property of pointing towards the Pole, and this about 400 Years since. The *Italians* first discovered, that it would communicate this Virtue to Steel or Iron. The various Declination of the Needle, under different Meridians, was first discovered by *Sebastian Cabott*; and its *Inclination* to the nearer Pole by our Countryman *Robert Norman*. The *Variation of the Declination*, so that 'tis not always the same in one and the same place, he observes, was taken Notice of but a few Years before, by *Hervelius*, *Auzout*, *Petit*, *Volckamer*, and others.

*The Properties, or Phænomena, of this wonderful Stone, as they have been discovered by Gilbert, Kircher, Cabeus, Des Cartes, and others, are these:*

1. That in every *Magnet* there are two Poles, one pointing North, the other South; and if a Stone be cut or broken into never so many Pieces, there are these two Poles in each Piece.

2. That these Poles in divers Parts of the Globe, are diversely inclined towards the Earth's Centre.

3. That these Poles, tho' contrary to one another, do help mutually toward the Magnet's Attraction and Suspension of Iron.

4. If two Magnets are Spherical, one will turn or conform itself to the other, so as either of them would do to the Earth; and that after they have so conformed or turned themselves, they endeavour to approach to join each other; but if placed in a contrary Position, they avoid each other.

5. If a Magnet be cut thro' the Axis, the Parts or Segments of the Stone, which before were joined, will now avoid and fly each other.

6. If the Magnet be cut by a Section perpendicular to its Axis, the two Points which before were conjoined, will become contrary Poles, one in one, the other in the other Segment.

7. Iron receives Virtue from the Magnet by Application to it, or barely from an Approach near it, though it doth not touch it; and the Iron receives this Virtue variously, according to the Parts of the Stone 'tis made to touch, or made approach to.

8. If an oblong Piece of Iron be any how applied to the Stone, it receives Virtue from it only as to its Length.

9. The Magnet loses none of its own Virtue by communicating any to the Iron, and this Virtue it can communicate to Iron very speedily; tho' the longer the Iron touches or joins the Stone, the longer will its communicated Virtue hold; and a better Magnet will communicate more of it and sooner, than one not so good.

10. That Steel receives Virtue from the Magnet better than Iron.

11. A Needle touch'd by a Magnet, will turn its Ends the same way towards the Poles of the World, as the Magnet will do it.

12. That neither Loadstone nor Needles touch'd by it, do conform their Poles exactly to those of the World, but have usually some Variation from them: And this Variation is different in divers Places, and at divers Time, in the same Place.

13. That a Loadstone will take up much more Iron when arm'd or cap'd, than it can alone: And that tho' an Iron Ring or Key be suspended by the Loadstone, yet the magnetical Particles do not hin-

der that Ring or Key from turning round any way either to the Right or Left.

14. That the Force of a Loadstone may be variously increased or lessened, by the various Application of Iron, or another Loadstone to it.

15. That a strong Magnet, at the least Distance from a lesser or a weaker, cannot draw it to a Piece of Iron adhering actually to such lesser or weaker Stone; but if it come to touch it, it can draw it from the other: But a weaker Magnet, or even a little Piece of Iron, can draw away or separate a Piece of Iron contiguous to a greater or stronger Loadstone.

16. That in our North Parts of the World, the South Pole of a Loadstone will raise up more Iron than the North Pole.

17. That a Plate of Iron only, but no other Body interposed, can impede the Operation of the Loadstone, either as to its attractive or directive Quality. Mr. *Boyle* found it true in Glasses sealed hermetically; and Glass is a Body as impervious as most are to any Effluvia.

18. That the Power or Virtue of a Loadstone may be impaired by lying long in a wrong Posture, as also by Rust, Wet, &c. and may be quite destroyed by Fire.

#### EXPERIMENTS of the Nature and Properties of the MAGNET.

1. Mr. *Boyle* found, that by heating a Magnet red hot, it could be speedily deprived of its *Attractive Quality*.

2. If a Loadstone be heated red hot, and then cooled either with its South Pole to the North, in a Horizontal Position, or with its South Pole downwards in a perpendicular one, it will change its Polarity, the South Pole becoming the Northern one, and *vice versa*.

3. By applying the Poles of a very small Fragment of a Loadstone, to the opposite vigorous ones of a good larger Magnet, Mr. *Boyle* found he could speedily change the Poles of the Fragment; but he could not effect it in a Fragment that was considerably bigger, tho' he tried many Hours.

4. He observed, That well-temper'd and harden'd Iron Tools, when heated by Attrition, Turning, Filing, &c. they would, while warm, attract thin Filings, or Chips of Iron and Steel, but not when cold. Yet I remember once to have seen myself, and tried, that a Piece of a File, which was in the Hands of Mr. *Yarwell* the Spectacle-Maker, did retain such an attractive Quality, that it would take up, and keep suspended, the Key of a Cabinet, or *Escrutoire*, and needed no Attrition to excite this magnetical Virtue.

5. The Iron Bars of Windows, which have long stood in an erect Position, do grow permanently magnetical, the lower Ends of such Bars being the North Poles, and the upper the Southern: For according to the Laws of *Magnetism*, we find the lower Ends of such Bars will drive away the North End of a poised Needle, and will attract the Southern; which shews, that by the continual Passage of the subtle magnetical Particles thro' them, they are turned into a kind of Magnet themselves.

6. If a Bar of Iron that hath not long stood in an erected Posture, be only held perpendicularly, its lower End will be the North Pole, and attract the South Point of a Touch'd Needle: But then this Virtue is transient, and will shift as you invert the Bar; for the other End when held lowermost, will



will presently become the North Pole; wherefore, in order to render the Quality of Verticity permanent in an Iron Bar, it must remain a long time in a proper Position. But the Fire will produce this Effect in a very short time; for as it will immediately deprive a Loadstone of its attractive Power, or change its Poles, (as in *Exper. 1, 2.*) so it will as soon give a Verticity to a Bar of Iron, if being heated red hot, it be cooled in an erect Position, or directly North and South. Nay, it hath been observed often, that even Tongs and Fire-forks, by being often heated, and then set to cool in a Position near to erect, have gained this magnetical Property.

The Reason of which very different Effects of the Fire on a Magnet, and on Iron, Mr. Boyle, with his usual Modesty, suggests to be this: That the peculiar Texture or Constitution by which a Magnet differs from common Iron Ore, being accurate and fine, is spoiled by the rude and violent Attacks of the Fire: But this mighty Agent, by working upon Iron, softens and opens the Pores of the Metal (which is harder than Iron Ore); so that it becomes capable of being pervaded by the magnetical Particles, and by that Means gains a *Vertical Quality*.

7. Mr. Boyle found that by heating a Piece of *English Oker* red hot, and placing it to cool in a proper Posture, it plainly gained a Magnetick Power.

8. The same noble Gentleman found, that an excellent Loadstone of his own, having lain almost a Year in an inconvenient Posture, had its Virtue so impaired, that he at first thought some Body had got at it, and spoiled it by Fire.

9. If a Needle be well touch'd on a good Loadstone, 'tis known it will, when duly poised, point North and South; but if it have one contrary Touch of the same Stone, it will immediately be deprived of that Faculty; and by another such Touch, it will have its Poles quite changed; so that the End which before pointed North, shall now point Southward.

10. Dr. Power, and Mr. Boyle both tried, that after a red-hot Iron had gain'd a *Verticity*, by being well heated and cooled North and South; and then also hammer'd at the Ends, this Virtue would immediately be destroyed by two or three Blows of a strong Hammer smartly given about the middle of it.

11. Mr. Boyle found by drawing the Back of a Knife, or long Piece of Steel Wire, &c. over the Pole of a Loadstone leisurely, once or divers times, beginning the Motion from the Equator or middle of the Stone, towards the Pole, the Knife or Wire will accordingly attract one End of a poised magnetical Needle; but if you take another Knife or Wire, and thrust it leisurely over the Pole, from the Pole towards the Equator or middle of the Stone, this Knife shall expel or drive away the same End of the Needle, which the former Knife would attract: Which Experiment makes it very probable, that the Operation of the Magnet depends on the Flux of some fine Particles, which go out at one Pole, then round about, and in again at the other.

12. Because it is one of the Universal Laws of Nature, That *Action and Reaction are always equal*: Therefore 'tis plain, the Iron must attract the Magnet, as much as that doth the Iron: And so you may easily experiment it to be in Fact, if you place a Magnet or Piece of Iron on a Piece of Cork, so as that it may swim freely in the

Water; for then you will see, that which soever you hold in your Hand, will draw the other towards it.

From all which Experiments, 'tis plain (as Mr. Boyle concludes) That *Magnetism doth much depend upon mechanical Principles*. As also, That there is such a Thing as the *Magnetism of the Earth*; or that there are *Magnetical Particles*, which continually are passing from Pole to Pole; but Sir Isaac Newton demonstrates, that *Gravity* is a very different Thing from *Magnetism*; since the former is always as the Quantity of Matter attracted, but *Magnetism* by no means so.

Mr. Joblot, Professor of the Mathematicks in the French Academy of Painting, &c. hath found out (as it is said) a Method of making Artificial Magnets.

MAGNETISM, or *Magnetical Attraction*, or, as some are pleased to call it, *Coition*; is effected (say they) by the *Effluvia* of each Body, which drive away the Air between the Iron and the Stone; so that an Union of the Stone and the Iron is occasion'd by the joint Protrusion or Pullion of the Air behind each.

But this Opinion is plainly refuted by Mr. Boyle's Experiment of a Loadstone's being equally Vigorous and Attractive in the exhausted Receiver, as in the open Air.

MAGNETISM. See Mr. Derham's Experiments and Reasonings on this Subject in *Phil. Transf.* N<sup>o</sup> 304; where he acquaints us, That he found (as Grimaldi and De la Hire had in Part done before) that a Piece of very well touched Iron Wire would, upon being bent round into a Ring, or coil'd round upon a Stick, &c. most times quite lose its Verticity, and always have it much diminished thereby. But yet that if the whole length of the Wire were not entirely bent, so that the Ends of it, tho' but for the Length of one tenth of an Inch, were left strait; then the Vertue would not be destroyed in those Parts or Ends; tho' it would every where else. He found also, on repeated Trials, that tho' coiling or bending the Wire as abovesaid, would always in the Day-time diminish and most times destroy the Verticity of a touch'd Wire; yet it would not do it in the Evenings: And he saith, and knows very well, that the Orb of the Activity of Magnets is larger or less at different times; which is confirmed by what is found in Fact to be true of our noble large Loadstone, which is kept in the Repository at Gresham-College; for that will keep a Key or other Piece of Iron suspended to another, sometimes at the Distance of 8 or 10 Foot from it; but at other times not beyond the Distance of four Foot.

He found also, that *twisting* the Wire would considerably diminish, and sometimes destroy the Verticity; which in some Tryals made on twisted Wire, was so *confused* and *disordered*, that he found by drawing one of the Poles of a Loadstone along near the Sides of the Wire, in some Places it would attract, in others repel, and so *attract* and *repel* all along the Wire; and he fancy'd in some Places, that one side of the Wire would be attracted, and the other repelled by one and the same Pole.

After this he try'd what *splitting* or *cleaving* the Wire would do; and in particular, whether split Wires would have the same Properties as Loadstones cut asunder, and he found the *Phænomena* of this Experiment very odd; for sometimes the Poles of the Wire so split would be quite chang'd; so that the South Pole would become the North in all Respects: Sometimes one half of the Wire

would



would retain its Magnetism which it had before its splitting, and the other half would have it quite changed, &c.

He observed also one thing to be very surprizing in these split Wires; which was, *That laying one, or the other Side of the Half uppermost*, would cause a great Alteration in its Tendency or Aversion to the Poles of the Magnet: But if you lay the contrary side of that half uppermost, the same End shall be attracted by one and repelled by the other Pole. In other Pieces where the Ends are regularly attracted or repelled, only in an inverted Order (as if new touched) if it lay with the round side uppermost at that time, and be then turned upside down, *viz.* the flat cleft side uppermost; it is ten to one, he saith, that one of the Ends is either attracted by both the Poles, or repelled by both; or else attracted and repelled by one, and in Hesitation by the other.

He touched a Wire from End to End, with only one Pole of the Magnet; which gave it so vigorous a Virtue, that he is almost of Opinion, *'tis the best Way of touching*; the Consequence was, that the End where he began always turned contrary to the Pole that touched it: He then touched the same Wire (and others likewise) with the other Pole of the same Magnet, from the same End, and then that End turned the contrary way. For Instance, mark one end of the Wire for the North End, and touch that Wire by drawing the North Pole of the Magnet divers times along the Wire from the North to the South End: This Wire so touched, shall have a vigorous Verticity; but the North End shall stand South. But if you touch that or another Wire, (for it is all one, the latter Touch destroying the former) by drawing the North Pole of the Magnet from the South to the North End of the Wire, then this North End will turn North: And so it will be if you touch with the Southern Pole from the North to the South.

He found also, that if he touch'd an Iron Wire exactly in the Middle with but one Pole of the *Loadstone*, without drawing it backwards or forwards, in that Place would be the Pole of the Wire; and the two Ends would be the contrary Pole of the Wire, and were accordingly repelled or attracted by the Poles of the Magnet; and the middle, and about an Inch more on each side, was attracted only by the Pole that touched it.

**MAGNETICAL Amplitude**, is an Arch of the Horizon, contain'd between the Sun at his Rising or Setting, and the East and West Point of the Compass: Or it is the different Rising or Setting of the Sun from the East or West Points of the Compass; and is found by observing the Sun at his Rising or Setting, by an *Amplitude Compass*.

**MAGNETICAL Azimuth**, is an Arch of the Horizon, contained between the Sun's *Azimuth Circle*, and the *Magnetical Meridian*: Or it is the apparent Distance of the Sun from the North or South Point of the Compass; and may be found by observing the Sun with an *Azimuth Compass*, when he is about 10 or 15 Degrees high, either in the Forenoon or Afternoon.

**MAGNETICAL Meridian**; See *Meridian*.

**MAGNIFY**, is a Word used chiefly in reference to *Microscopes*; which are usually said to *magnify* Objects, or to make them appear bigger than they really are.

But in reality, *Microscopes* do not, nor can at all *magnify* any Object, but only shew more of it to the Eye than before was taken Notice of; as

will be apparent from the following Considerations

For, First, 'Tis clear that the Images of all Objects which are represented or pictured on the *Retina* in the Bottom of our Eyes, (and by which way all Vision is made) those Images, I say, must of Necessity be very small, in Proportion to the Objects themselves; as is demonstrable to any one's Reason, that will consider the Smallness of the *Fundus Oculi*; and to his Senses, that will but take the Pains to try the *Cartesian* Experiment, of putting a Bullock's Eye in the Hole of a darkened Room. (Vid. *Cart. Diopt.* cap. 5.) Now there being no Reason to suppose, that the bare Communication of that Picture to the Brain by the Optick Nerve, or Animal Spirits can magnify it again, so as to equal it with the Objects themselves; it must and doth follow, that we always have Things represented to us less than they are, in the common way of Vision.

2. At any considerable Distance we see but very little of the Object we behold, in Comparison of what evades our Sight; and the nearer we come to it, the more we still discover of it; and whenever we look in gross upon an Object, our Eye cannot take Notice of many minute Differences, which, when we come to observe them singly, do yet very plainly appear; and after the nearest View we can make with our bare Eye, very many Parts will yet remain undiscoverable to us: So that all that the *Microscope* doth, is (by taking off the Circular Radiation of Light) to direct our Eye to contemplate these minute Parts distinctly, singly, or by themselves, which before we could either but confusedly, or not at all, discern; and which now appearing (our Eyes thus armed with a Glass) very plain to us, make us attribute a new Magnitude to the Body we look on, because we cannot imagine it can have those Parts (which we now so distinctly see, and which before we could not see) unless its visible Parts lie farther asunder from each other than they did before, to make Room for these new to come between them.

3. But 'tis yet farther plain, that 'tis impossible any Glass can *magnify* an Object, or make it bigger to us than it really is in it self: For to do this, must be to give it new Parts, and to remove the visible Parts it hath already to a greater Distance from each other; both which are utterly impossible.

4. If you make a very small Hole in a Piece of Tin or Brass, and look thro' it on any Object, it will make it appear much bigger than before, and so much bigger as the Hole is lesser; which plainly proves, that the Reason of any Object's appearing bigger thro' a *Microscope* is, as before, only bringing the Object nearer to the Eye, and letting some Parts of it be seen, which before were not discoverable by the bare Eye.

**MAGNIFYING Glass** [in *Opticks*] A little Sphere, Convex Lens, &c. which affects the Rays of Light so in transmitting them, as that the Parallel ones become converging, and those which were diverging become parallel, by which Means the Objects seen through them appear larger than when view'd by the naked Eye.

**MAILE**, was anciently a Kind of Money, as some think; for *Mailes* were Half-pence in *Henry* the Fifth's Time; being the half of the Silver *Sterling* or Penny: But more largely it seems to have been any Proportion of Grain, or any other *Rent*.



This latter in the North is called *Black-mail*. See *Black-mail* in Vol. I.

MAIM, or *Mayhim*, in Common Law, signifies a Corporeal Hurt, by which a Man loseth the Use of any Member that is or might be of any Defence to him in Battel. But the cutting off an Ear, or Nose, the breaking of the hinder Teeth, or such like, is no *Maim*; and rather a Deformity of the Body, than diminishing of Strength: Yet cutting off a Nose, or cutting or disabling any Limb or Member, is Felony without Benefit of the Clergy.

*Maim* is commonly tried by the Justices inspecting the Party; and if they doubt whether it be a *Maim*, or not, they use to take the Opinion of some able Surgeon.

MAIN BODY, of Troops in an Army, is that which marches between the *Advance* and the *Rear Guard*; and in a Camp, that which lies between the two Wings.

MAIN-Mast of a Ship, is a long, large, and round Piece of Timber, standing upright in her Middle or Waste, on which is born her *Main-Yard*, and *Main-Sail*. Its Length is usually  $2\frac{1}{2}$  of the Length of the Mid-ship Beam.

MAIN-TOP-Mast, is one half of the Length of the *Main-mast*; and the *Top-gallant-mast* half the Length of the *Main-top-mast*.

MAINOUR, *Manour*; or *Meinour*, in a Legal Sense, signifieth a Thing that a Thief taketh away, or stealeth: As to be taken with the *Mainour*, is to be taken with the Thing stollen about him.

MAINPERNABLE, is he that may be let to Bail. See the Statute of *Westm. 1. cap. 15. made Anno 3. E. 1.* what Persons be *mainpernable*, and what not.

MAINPERNORS, are those Persons to whom a Person is delivered out of Custody or Prison, and they become Security for him, either for Appearance, or Satisfaction. They are called *Manucaptors*, because they do as it were *manu capere & ducere captivum e custodia vel prisiona*: And the Prisoner is said to be delivered to *Bail*, from the Words of the *Bail-piece*, viz. A. B. &c. *traditur in Ballium J. D. & R. R. &c.*

MAINPRISE, in our Law, signifies the taking or receiving a Man into Friendly Custody, that otherwise is or might be committed to Prison, upon Security given for his Forth-coming at a Day assigned: And they that thus undertake for any, are called *Mainpernors*, (which see) because they receive him into their Hands; whence also comes the Word *Mainpernable*, denoting him that may be thus bail'd: For in many Cases a Man is not *mainpernable*; whereof see *Bro. Tit. Mainprise per totum*; and *F. N. B. fol. 249.* When *Mainprises* may be granted, and when not, see *Crompt. Justic. of Peace. fol. 136, and 141.* And the *Mirror of Justices* says, That *Pledges* be those that Bail or Redeem any Thing but the Body of the Man; but *Mainpernors* are those that free the Body of a Man; and therefore that *Pledges* belong properly to real and mix'd Actions, and *Mainpernors* to personal.

MAINTAINOR, is he that supports or seconds a Cause depending in Suit between others, either by disbursing Money, or making Friends for either Party, towards his Help.

MAINTENANCE, is a Law-Term, signifying the Act of a *Maintainer*, when he seconds a Cause depending between others: And when it is accounted *Maintenance*, and when not, see *Broke Tit.*

*Maintenance*. The Writ that lies against a Man for this Offence, is also called *Maintenance*.

MAJOR and MINOR [in *Musick*] Terms us'd of the Concords which differ from each other by Semitone.

MAJOR-General, is an Officer in an Army, that receives the General's Orders, and delivers them out to the Majors of the Brigades, with whom he concerts what Troops are to mount the Guard, what to go out upon Parties, what to form Detachments, or to be sent on Convoys, &c. 'Tis his Business also to view the Ground to incamp on, and he is next subordinate to the General and Lieutenant-General.

MAJOR of a Brigade, either of Horse or Foot, is he that receives Orders, and the Word, from the Major-General, and gives them to the particular Majors of each Regiment. And the

MAJOR of a Regiment, is an Officer whose Business it is to convey all Orders to the Regiment; to draw it up, and to exercise it; to see it march in good Order, to look to its Quarters, and to rally it, if it happen to be broken in an Engagement, &c. He is the only Officer in a Regiment of Foot, that is allowed to be on Horseback in Time of Service; but he is mounted, that he may speedily get from Place to Place, as Occasion serves. There is also in a Garrison an Officer next to the Deputy-Governor, which is called the *Town-*

MAJOR; He ought to understand Fortification, and hath Charge of the Guards, Rounds, Patrolles and Centinels.

MAJUS-Fus, is a Writ or Proceeding in some Customary Manors, in order to a Tryal of Right of Land.

MAKE; a Word frequently used by Lawyers, signifying, to perform or execute: As, to *make his Law*, is to perform that Law which he hath formerly bound himself to; that is, to clear himself of an Action commenced against him, by his Oath, and the Oaths of his Neighbours. To *make Services* or *Customs*, is nothing else but to perform them; and to *make Oath*, is to take Oath.

MALACIA, [*μαλακία* Gr.] is a depraved Appetite, which covets those Things which are not fit to be eaten; also a Tenderness of Body. *Blanchard.*

MALACTICA, or *Emollientia*, [*μαλακτικα* of *μαλακω* Gr to mollify,] are Things which soften the Parts by a moderate Heat and Moisture, by dissolving some of them, and dissipating others. *Blanchard.*

MALAGMA, [*μαλαγμα* Gr.] the same with *Cataplasm*; also 'tis used in the same Sense as *Malactica*.

MALETENT, or *Maletolte*; in the Statute called the *Confirmation of the Liberties*, 25 Ed. 1. c. 7. is interpreted to be a Toll of 40 s. for every Sack of Wooll; and in the Statute *de Tallagio non concedendo* in the 36th Year of the same King Edw. 1. 'tis appointed, that Nothing for hereafter shall be taken of Sacks of Wooll, under the Pretence of *Maletent*. It seems to come from *malum Telonium*.

MALEDICTION [in *Law*] A Curse ordinarily annexed to Donations of Lands, &c. to Churches, &c. imprecating the most direful Punishments to those that shall infringe them.

MALIGNUS Morbus, a malignant Disease, is that which rages more vehemently and continues longer than its Nature usually permits it to do; as a Pestilential Fever, &c.

MALIGNANT



**MALIGNANT** [in *Physick*] see *Morbus malignus*.

**MALLEABIE**, that which will bear being hammered, and spread, being beaten. This Quality belongs in the highest Degree to Gold, which is the most *ductile* or *malleable* of any Metal whatever. Mr. *Boyle* reckons the Qualifications requisite to Malleableness, to be, Having the Corpuscles or Particles of such an adapted Size, Shape, and Figure, whether hooked, branched, &c. that they can take fast hold of one another, and stick so close, as to make the Body spread easily under the Hammer, and not break nor crack.

**MALLEUS**, is one of the Four little Bones in the Ear.

**MALLEOLUS**, or *Malleus Pedis*, is Two-fold: *External*, which is the lower Process at the Foot of the Bone of the Leg, called *Fibula*; or *Internal*, which is the lower Process of the Bone of the Leg, called *Tibia*: These make up or form the Ankle.

*Malleolus* is also used as a Term in Botany, for a Sprout that grows out of a Branch which grew out its self but the Year before. *Columella*.

**MALTHACODE**, [*μαλθακωδης* Gr.] is a Medicine softened with Wax. *Blanchard*.

**MALUM Mortuum**, the Dead Disease, is a sort of Scab; so called, because it makes the Body appear black and mortified. It is in Colour black and inclining to blue, and appears with a crusty sort of Pimples, unseemly, and filthy, but without sending out Matter, or giving the Patient Pain. It infects the Hips and Legs especially. *Blanchard*.

**MALTHA**, a kind of Cement anciently much used, composed of Pitch, Wax, Plaister, and Grease.

Also another made of Lime slaked in Wine incorporated with melted Pitch and fresh Figs, with this last the *Romans* plaistered the Insides of their Aquæducts.

*Natural* **MALTHA**, a kind of Bitumen, with which the People of *Asia* used to plaister their Walls. If this *Maltha* be once set on Fire, Water will not extinguish it, but rather make it burn more fiercely.

**MAMILLARY Artery**, or the *Mammaria*, is a Branch of the Arteries which supplies the Breasts, and issues out of the adjoining Trunk of the *Aorta*, as some say; but more properly it ought to be said to come from the superior Part of the Subclavian Branch of the Ascending Trunk of the *Aorta*.

**MAMMA**, *Mammilla*, *Uber*, the Breasts, Dugs, &c. The *Grammarians* call the inner Part *Ubera*, and the outward Protuberances *Mammæ*. The Substance of the Breasts is a white and soft Body, consisting internally of a Congeries of Conglomerated Glandules, by the means whereof the Milk is separated from the Arterious Blood, and is conveyed out by very little Pipes, which pass through the Nipples.

**MAMMARY Vessels**, are the Arteries and Veins that run through the Muscles and Glands of the Breasts.

**MAMMIFORMES Processus**, are the two Apophyses of the Bone of the back-part of the Skull.

**MAN-BOTE**, was formerly a Récompence for Homicide, or a pecuniary Compensation for killing a Man.

**MANCA**, was formerly a squat Piece of Gold, commonly valued at 30 Pence; and *Mancusa* was

as much as a Mark of Silver. See *Canute's Laws*. 'Twas called *Mancusa*, quasi *Manu cusa*.

**MANCUSA**. See *Manca*.

**MANCIPLE**, a Caterer; there was anciently an Officer in the Temple called by this Name, now the *Steward*. And the Name and Office is retained still in our Colleges, in both our Universities.

**MANDAMUS**, is a Writ that lieth after the Year and Day; whereas in the mean Time the Writ called *Diem clausit extremum* hath not been sent out to the Escheator for the same Purpose to which it should have been sent forth. See *Diem clausit extremum*.

*Mandamus* is also a Charge to the Sheriff, to take into the King's Hands all the Lands and Tenements of the King's Widow, that against her Oath formerly given, marrieth without the King's Consent.

**MANDATE**, is a Commandment of the King, or his Justices, to have any thing done for Dispatch of Justice; whereof you shall see Diversity in the Table of the Register *Judicial verbo Mandatum*.

**MANDATARY**, in Law, is he to whom a Charge or Commandment is given: Also he that obtains a Benefice by *Mandamus*.

**MANDIBULA**, or rather *Maxilla*, the Jaw; is either *Upper* or *Lower*. The *Upper* Mandible consists of Twelve Bones, on each Side Six. The First is at the external Corner of the Eye, which joined with the Fore-process of the Bone of the Temples, produces the *Jugal Bone*. The Second constitutes the inner Corner of the Eye, has a large Passage in it, by which the super-abundant Moisture of the Eye descends to the Nostrils. The Third is within the Circle of the Eye, interposed betwixt the other two. The Fourth, the greatest of all, forms the greatest Part of the Cheeks and the Palate, and is elaborately contrived with proper Cavities for the Reception of the Teeth. The Fifth helps to make the Nose. The Sixth, with another Bone along with it, terminates the Extremity of the Palate. And all those are joined rather by a plain Line, than by Sutures. The *Lower* Jaw, at riper Years, grows into one continued Bone, extreme hard and thick, and consequently very strong. It has two Processes, one Acute, called *Corone*; and the other in the Form of a little Head, called *Condylus*. It has two Holes within, and as many without, which make way for the Nerves: The under Teeth are implanted in it, and is jointed with the inner side of the Bone of the Temples, called *Os petrosum*. To these Twelve Bones, *Columbus* and *Laurentius* are for adding a Thirteenth, which, they say, lies between the innermost Space and the *Os sphaeroides*, dividing the most inward Part of the Nostrils into two Parts, like a *Septum*; and therefore they call it *Vomer*. To these *B. Vesalius* would have the *Ossa spongiosa*, which are in the innermost Cavity of the Nose, to be added also.

**MANDERIL**, [in the Art of Turnery] a kind of wooden Pully that makes a Member of the Leath.

**MANGER** in a Ship, is a Circular Place made with Planks fastened on the Deck, right under the *Hawses*, being about a Foot and a half in Height: The Use of which is to catch and receive the Sea-water, beating in at the *Hawses* in a Stress of Weather.



MANIA, [*μανία* Gr.] a sort of Madness, is a Deprivation of Imagination and Judgment, with great Rage and Anger, but without a Fever; altho' a Fever may be joined with a *Mania* proceeding from some other Cause.

MANICA *Hippocratis*, or *Hippocrates his Sleeve*, is a Woollen Sack or Bag, in Form of a Pyramid; wherewith *Aromatick* Wines, Medicines, and many other Liquors are strained. 'Tis so called by the Chymists.

MANIPULUS, is a Dry Measure, usual with Physicians in their Prescriptions: For it is a determinate Quantity, to wit, as much as can be held in one Hand, meant for the most part of Herbs.

*Fasciculus* is a different Quantity from

*Manipulus*, an Handful; for it properly signifies an Armful.

MANNER, a Word now much in Use, which we have borrowed from the French *Maniere*. In Painting, it signifies the Usage, Way, *Mode*, or *Manner* any Painter has acquired, not only in the Management of his Hand or Pencil, but also as to his Observance of the Three principal Parts of Painting, *Invention*, *Design*, and *Colour*: And according as any one hath gotten a Habit or peculiar Way of Painting, we say, He has such a *Manner*. If it be agreeable to the Rules of this Art, Natural, Strong, Easy, and duly Proportioned, we say, 'Tis a *Good manner*; and if the contrary, A *Bad manner*. If he imitate any famous Ancient Painter, as *Mich. Angelo*, *Raphael*, &c. we say, He *paints after their manner*. So 'tis also in Sculpture; and now-a-days in *Singing*, or *Playing* on any Instrument: When we would express our Approbation of any one's Way of *Singing* or *Playing*, we say, He *hath a very Good manner*.

MANNER, [in *Poetry*] is used to signify the Genius, Inclination and Humour which the Poet gives to his Person, or that which distinguishes his Characters.

MANNER; besides what hath been said about *Manner*, I must take notice that they say in *Architecture*, That an Order Heroically and Gigantically designed; where the Division of the principal Members is put into a few Parts; but those having all a bold and ample *Relievo*, is after the *Grand Manner*. As for Example, in a *Corniche*, if the *Gola* or *Cimatium* of the *Corona*; the *Coping*, the *Modillions* or *Dentelli* make a noble Appearance by the Gracefulness of their Projectures; and that we see none of that ordinary Confusion which results from those little Cavities, *quarter Rounds* of the *Astragal*, and such little Ornaments as produce no effect in great and massy Works, and which do impertinently jumble out the graceful and principal Members; then will the *Manner* of this *Corniche* appear *solemn* and *great*, and approve it self to be performed after *La Grand Maniere*. In Mr. *Evelyn's* Parallel of Ancient and Modern *Architecture*, Chap. 5. p. 25. you have a fine Draught of this *Grand Manner*, in an ancient Dorick Pillar which was found at *Albano*, joining to the Church of St. *Mary* near *Rome*.

MANNEQUIN, [with *Painters*] a little Statue or Model, made sometimes of Wax, and sometimes of Wood; the Junctures or Joints of which are so contriv'd, as that it may be put into any Altitude the Artist pleases, and the Draperies and Folds of the Garments be adjusted or disposed at Discretion.

MANNOPUS, a Term in the Common Law, signifying Goods taken in the Hand of an apprehended Thief.

MANOR, was a Noble sort of Fee granted partly to Tenants for certain Services to be performed, and partly reserved to the Use of the Family, with Jurisdiction over his Tenants for their Farms: The whole Fee was termed a *Lordship*, of Old a *Barony*; from whence the Court, that is always an Appendant to the *Manor* is called, The *Court-Baron*. Now a *Manor* rather signifies the Jurisdiction and Royalty incorporeal, than the Land or Site: For a Man may have a *Manor in gross*, that is, the Right and Interest of a Court-Baron, with the Perquisites thereunto belonging; and another, or others have every Foot of the Land. But at this Day a *Manor* cannot be made, because a *Court-Baron* cannot now be made, and a *Manor* cannot be without a *Court-Baron*.

MANSE, is a Parsonage or Vicarage-House for the Incumbent to live in, and was originally, and is now, an essential Part of the Endowment of a Parish-Church, together with the Glebe and Tithes.

MAN-SLAUGHTER, is the unlawful killing of a Man, without premeditated Malice: As when two, that formerly meant no Harm one to another, meet together, and upon some sudden Occasion falling out, the one killeth the other. It differeth from *Murder*, because it is not done with foregoing Malice; and from *Chance-medley*, because it hath a present Intent to kill. And this is Felony, but admitted to the Benefit of the Clergy for the first Time.

MANTELETS, in Fortification, are a kind of moveable Pent-houses, and are made of Pieces of Timber saw'd into Planks; which being about three Inches thick, are nail'd one over another to the Height of almost six Foot. They are generally cas'd with Tin, and set upon little Wheels, so that in a Siege they may be driven before the Pioneers, and serve as Blinds, to shelter them from the Enemies Small-shot. There are also other Sorts of *Mantelets*, cover'd on the Top, whereof the Miners make use to approach the Walls of a Town or Castle.

MANTLE, in *Heraldry*, is that Appearance of the Foldings of Cloth, Flourishing or Drapery that is in any Achievement drawn about a Coat of Arms: 'Tis supposed to have formerly been the Representation of a Mantle of State in Blazon; 'tis always said to be doubled, *i. e.* lined throughout with one of the Furs, as Ermin, Pean, Verry, &c.

MANTLE-Tree [in *Architecture*] is the lower part of a Chimney, or that part laid across the Jaumbs, and which sustain the Compartment of the Chimney-piece.

MANUALIA *Beneficia*, were formerly such daily Distributions or Portions of Meat and Drink, as were allotted to the Petty Canons and other Members of Cathedral Churches for their ordinary Subsistence.

MANUCAPTIO, is a Writ that lies for a Man, who taken upon Suspicion of Felony, and offering sufficient Bail for his Appearance, cannot be admitted thereto by the Sheriff, or other having Power to let to *Mainprize*.

MANUMISSION, is the Term for making a Slave or a Bondman free: You have the Form of this as it was used in the *Conqueror's* Time, in *Lambert's Aschamoria*, Fol. 126. The *Terms of the Law* make two Kinds of *Manumission*; one expressed, and the other implied: That expressed was by Deed, or *Publick Declaration*: That implied was when the Lord made an Obligation for Payment of Money to his Villain at a certain Day; or sued him when he might enter without Suit;



or when he granted him an Annuity, or Leafed Land to him for Years, or for Life, &c.

MANU-OPERA, are stolen Goods taken upon a Thief apprehended in the Fact.

MANU-PASTUS, in the Law Dialect, is often used for a Domestick Servant, one fed, as it were, by the Hand of his Master.

MANU-PES, is used in the Charter of Richard the Third for a Foot of full and legal Length.

MANU-PRISOR, one who was Bail-pledge or Security for another Person.

MANUS, was anciently used both for an Oath and him that took it. If a Man swore alone in the Court, he was said to do it *propria manu*; but if he brought three or more Witnesses to swear for him, he was said *tertia manu jurare*.

MANUS *Christi*, is a sort of refined Sugar, so called, because it is put into Cordials for very weak People. *Blanchard*.

MANUTENENTIA, is a Writ used in case of Maintenance. See *Maintenance*.

MANWORTH [in old *Law-Books*] the Price or Value of a Man's Head, every Man being rated at a certain Price according to his Degree; according to which, in old time, Satisfaction was made to his Lord, if any Person kill'd a Man.

MAP, is a Description of the Earth, or some particular Part thereof, projected upon a plain Superficies; describing the Form of Countries, Rivers, Situation of Cities, Hills, Woods, and other Remarks.

MARASMODES, [*μαρασμῶδης*, of *μαράινω*, Gr. *to decay*] is the Term for a Fever, which at last ends in a Consumption.

MARASMUS [*μαρασμός*, of *μαράινω*, Gr. *to waste*] an extreme Maciation or Consumption of the whole Body.

MARAVEDIS, a little *Spanish* Coin of Copper, in Value something more than a *French Denier*.

MARCHASITE, is the General Term for a *Mineral Body*, having in it some Metalline Parts; tho' many of them hold but a very little Quantity of Metal. See *Fossils*.

MARCHET } *Mulieris*, the same with *Mer-*  
MARCHETA } *chetum*.

MARCHES, are now the Bounds between *England* and *Wales*, or *England* and *Scotland*; and the *Marches* of *Scotland* are divided into *West* and *Middle Marches*. The Word *Marches* is used also in *Stat. 24. Hen. 8. 12.* for the Borders of the King's Dominions in general, as being derived from the *Germ. March*, which signifies a Bound or Limit; and those Noblemen who lived near these *Marches*, are frequently in our Statutes called *Marchers*.

MARINE Barometer. See *Barometer*.

MARISCA, the same that *Ficus*.

MARITAGIUM *habere*, signified formerly to have the free Disposal of an Heiress in Marriage, which was a Favour granted by the King, who was the Guardian of all Wards or Heirs in Minority, to some special Favourite or Friend.

MARITAGIUM *Liberum*, *Frank Marriage*, was when a Baron, Knight, or Freeholder granted such a Part of his Estate with a Daughter to her Husband, and the Heirs of his Body, to hold without any Homage or Service to the Donor.

MARITAGIO *amisso per defaultam*, is a Writ for the Tenant in *Frank-Marriage*, to recover Lands, &c. whereof he is divorced by another.

MARITAGIO *Forisfacto*. See *Forfeiture of Marriage*.

MARK, the *Saxons* called it *Mancus*, *Mancusa*, and *Mearc*; and among them it contained Thirty Pence, which of their Money was Six Shillings. 'Tis not certain when the *Mark* came to be valued as at 13 s. 4 d. But *M. Paris*, in the Life of *Guarinus* Abbot of *St. Albans*, tells us, that a *Mark* (*A. D.* 1194.) was of this precise Value. Since the *Conquest* there was never any Coin of this Name struck, as appears; but probably there might be such before in the *Saxons* Time, and with some *Mark* or Stamp upon it, as may be concluded from the Word *Mark*. *Stow* in his *Annals*, p. 32. and 691, saith, a *Mark* of Gold was eight Ounces, twelve *Mark* of Gold *Troy* was 200 l. of *English* Money; after which Rate each *Mark* weighed 16 l. 13 s. 4 d.

*Skene de Verb. signif.* saith, a *Mark* signifies an Ounce Weight, whereof the Drachm is the eighth Part, as the Ounce is the eighth of the *Mark*.

MARLINE, is a small Line made of Hemp untwisted, that it may be the more gentle and pliable; its Use is to seize the Ends of Ropes from farcing out: They use it also to seize the Straps at the Arse (as they call it) or lower End of the Block. *Marling a Sail*, is, when being so ript out of the Bolt Rope, that it cannot be sewed in again, the Sail is fasten'd by *Marline*, put thro' the Eye-let Holes made in it for that Purpose unto the Bolt-Rope.

MARLINE Spikes, are small Spikes of Iron made for the splicing together of small Ropes; and also to open the Bolt Ropes when the Sails are sewed into them. They are only a kind of small Fidd; which see.

MARMORATA *Aurium*, Ear-wax, is a certain Excrement of the Ear, laid there in the Auditory Passage from the Openings of the Arteries, or Sweat out from the Cartilages.

MARQUETRY, a sort of inlaid Work, compos'd of many different Pieces of hard fine Wood, of different Colours, cut into thin Plates or Slices, and fastened on a Ground, and sometimes enrich'd with Ivory, Tin, Brass, Tortoise-shell, &c. also some are made in the like manner with Marble; others with Glass, and some with precious Stones.

MARQUIS or ? is now a Title of Honour next

MARQUESS } before an Earl, and next after a Duke. The Name seems to be derived from the *Germ. March*, a Bound or Limit; and therefore was as much as *Custos Limitis*, or *Comes sibi Praefectus Limitis*. Among the old *Britains* it was the Custom, and after them of the *Saxons*, to give the Title of *Reguli* to all the Lords that had the Custody and Charges of their *Marches* or *Bounds*; as *Selden* shews in his *Mare Clausum*, Lib. 2. c. 19. But in *Richard II.* his time, the Title of *Marquesses*, instead of *Lords Marches* came to be given to such as were Governors of the *Marches*.

MARROW. See *Medulla*.

MARS. Mr. *Flamsteed* and *Cassini* have, by accurate Observations, found the horizontal Parallax of this Planet to be about 25 Seconds, and certainly not greater.

MARS, the Name of one of the Planets which moves round the Sun in an Orbit between that of the Earth and *Jupiter*.

To view this Planet, there requires a good Telescope, with small Apertures on the Object-glass, or else his Glairy Light makes but a confused Appearance.

This Planet, as well as the rest, borrows its Light from the Sun, and has its Increase and Decrease of Light like the Moon; and it may be seen



almost bisected when in his Quadratures with the *Sun*, or in his *Perigæon*, but never cornicated or falcated as the other Inferiors.

*March* 10, 1665. Dr. *Hook* observed this Planet, with a 36 Foot Tube, and saw its Body as large very near as the *Moon* at Full; and in it he observed several Spots, and particularly a triangular one; which having a Motion, he concluded the Planet to have a turbinated Motion round its Centre.

In the Year 1666, *February* the 6th, in the Morning, Mr. *Cassini*, with a 16 Foot Telescope, observed two dark Spots in the first Face of *Mars*, moving from 11 at Night until break of Day.

*February* the 24th in the Evening, he saw two other Spots in the other Face of this Planet, like those of the first, but much bigger: And continuing the Observations, he found the Spots of these two Faces to turn by little and little from East to West, and to return at the Space of 24 Hours, 40 Minutes, to the same Situation, wherein they were seen at first.

Whence he concluded, That the Revolution of this Planet round its Axis, is perform'd in the space of 24 Hours, 40 Minutes, or thereabouts.

The Distance of *Mars* from the *Sun*, is about one and an half of that of the Earth from the *Sun*; and therefore to an Eye placed in *Mars*, the Diameter of the *Sun* would appear by one and an half less than it doth to us, and consequently his Light and Heat will be but half of what it is here on our Earth; but this admits of a sensible Variation, because of the great Eccentricity of *Mars* his Orbit, yet not so great as in *Mercury*.

*Mars* his Year is almost twice as long as ours, and his *Natural Day* a little greater than ours; but his *Artificial Day*, or the Time in which the *Sun* appears above his Horizon (besides the Twilight before Sun-rise, and after Sun-set, according to the daily Height of the Atmosphere) is almost every where equal to his Night; and consequently, in one and the same place on his Surface, there can be but little Variety of Seasons as to Summer and Winter, &c. the Reason of which is, That the Axis of the Diurnal Revolution of this Planet, is nearly at Right Angles with the Plane of the Orbit. But Places situate in divers Latitudes, or at divers Distances from his Equator, will have very different Degrees of Heat, by reason of the different Inclination of the *Sun*'s Rays to the Horizon; as is the Case of our Earth when the *Sun* is in the Equinoxes.

And from hence the Learned Dr. *Gregory*, in his *Astronom. Phys. & Geometr.* p. 473, conjectures very probably, That the *Fasciæ* of this Planet do arise: which are certain *Swathes* or *Fillets* which appear in *Mars*, and are posited parallel to his Equator. For since there is always in the same Climate (*here*) nearly the same Degree of Heat, 'tis likely, that these Spots in *Mars* owing their Original to Heat and Cold, (as in our Earth Clouds and Snow do) may be extended in the said Climates in Parallels to the Equator, or to the Circle of *Mars*'s Diurnal Revolution, and so form the *Fasciæ*. And the same is true of *Jupiter*, which, as well as *Mars*, hath a perpetual Equinox.

That *Mars* hath an Atmosphere, like ours, is argued from the Phænomena of the Fixed Stars appearing obscur'd, and, as it were, extinct, when they are seen just by the Body of *Mars*: And if so, a Spectator in *Mars* will hardly ever see *Mercury*, unless it may be in the *Sun*, when that Planet passes over his Disk like a Spot, as he doth sometimes to us.

To an Eye in *Mars*, *Venus* will appear about as far from the *Sun*, as *Mercury* doth from him with us; and the Earth, as far as *Venus* appears to us, to be from the *Sun*. And when the Earth, being seen from *Mars*, appears in Conjunction with, and very near to the *Sun*, the *Martial* Spectator will see that which *Cassini* once or twice saw in *Venus*, viz. the lower Planet (or the Earth) appear horned or falcated; and its Satellite, the *Moon* of the same Figure, and at its greatest Distance, not above 15 Minutes of a Degree from the Earth. *Greg. Astronom.*

MARS [with *Astrologers*] is held to be a Masculine Planet, nocturnal, hot and dry, and to be a malignant Planet, and by them is called the *Little Unfortunate*.

MARS [amongst the *Chymists*] signifies Iron, because imagined under the Influence of that Planet. Naturalists abundantly inform us concerning the Production of this Metal; and physical Writers sufficiently prove how much it is preferable, for all medicinal Purposes, to Steel, which is only a more hardened compact Iron, made so by Art, whereby it is render'd more unfit to yield those Principles or Parts in Preparation; which the Physician requires to be drawn out. And because this has so great a share in Medicine, it is worth explaining by what manifest Properties this Metal comes to afford so much of moment for such Uses: And to this purpose thus far in common may be concluded, as from all other metalline Particles, That such as can be mixed with the Blood, and made part of the circulating Fluid, must of course, by the necessary Laws of Motion, from their superior Gravities, be of great Force to break their way, where Particles of less Gravities cannot get through: For Mechanics teach nothing more plainly, than that the *Momenta* of all Percussions, are as the Rectangles under the Gravities and the Celerities of the moving Bodies; by how much more Gravity then a metalline Particle has beyond any other Particles in the Blood, if their Celerities are equal, by so much the greater will the Stroke of the metalline Particle be against every thing that stands in its way, than of any other not so heavy, and therefore will any Obstructions in the Glands and Capillaries be sooner removed by such Particles, than by those which are lighter. This is a way of Reasoning that is plain to the meanest Capacity; and altho' it may be called mathematical, a Name shocking to some in Physic, yet it has no Conjunction in it, unless to force Assent by Demonstration.

But if Steel or Iron has this Property by virtue of the Solidity and specific Weight of its Particles, in common with some other Metals, it has also somewhat further of an Advantage of being a powerful Deobstruent, from the Shape of its component Parts; for both our Sight and Taste convince us of their pointed angular Forms, especially if we view them in their Shoots into Crystals, in making the Vitriol or Salt of Iron: For another Reason therefore, that is, the sharp and pointed Figures of the Particles of Iron, will they be efficacious to cut their way through many Hindrances; so that upon a double account we see how this Metal deserves its Esteem of being a noble Deobstruent. What has been observed likewise concerning Fermentation, or intestine Motion being increased by Particles elastic, does also plainly account how this Medicine comes to heat the Blood; for the Resilition of an elastic Particle, upon its Occursion against anything that stops it, contributes to increase another kind of Motion in a circulating Fluid, than that



that which is parallel to the Axis of the Vessel through which it is propelled; and it is this mixed Motion, upon which the Heat and Fluidity of the Blood depends; so that the chalybeate Particles being also elastic, they do heat and thin the Blood, by promoting its intestine Motion, as well as help it thro' Passages, by increasing its Weight and Force against them.

There is another obvious Property of Iron, and many of its Preparations, which we have never yet had tolerably accounted for; and that is, its Astringency in the Bowels, and its promoting of Urine; which may to some, at first sight, seem to be different Effects from the same Cause: But this will not appear strange, when we consider its stiptick corrugating Taste upon the Tongue, which cannot but arise from the Points and Angles of its Particles. When therefore it comes into the Bowels, as often as those Particles touch any of the Fibres of their inner Coat, those Fibres by the same Mechanism will contract; and so by the Passage of a Chalybeate through the Intestines, will they be gently drawn into such Corrugations, as to retain their Contents longer by the Passages being rendered straiter. And that these Medicines have this Effect in the Bowels by this means, is further evident from the Twitches they give the Stomach sometimes at their first Admission, insomuch as to draw it frequently into a general Contraction, and occasion their Ejection by Vomit.

Upon another Account also does Iron astringe in those Parts, and that is, by hardening the Fæces themselves, whereby they are longer restrained. In the crude Contents of the Bowels, there are many Particles gross and large in their Surfaces, which may be the fibrous Part of Food not digested enough to go off any other way but by Stool. Now these Filaments, or little Shreds of Fibres, tho' in themselves inanimate, are capable in themselves of Contraction, or rather Corrugation, upon the Contact and Impulse of a sharp-pointed Particle, as we see in Leather, Vellum, or any other membranous Substances, how they will shrink up at the Contact of Particles of Fire, or any subtle Acid; so that besides hardening the Coats of the Intestines, the Particles of a chalybeate Medicine astringe; that is, occasion more consistent and less frequent Stools, by hardening the Contents of the Bowels, and rendering them more slow of Expulsion: But the Case is very different when these Particles are strained into a Fluid as fine as themselves, and are propelled in Canals with a great Velocity. Tho' smart and frequently repeated Vibrations of an Artery, prevent any such Contact as was admitted of in the Bowels, and only serves to forward their Motions; so that they can do nothing here but go on with the Current, until their Force strikes them thro' some secretory Outlet: But by their Rapidity and more forcible Resilitions upon all Occasions, they cannot in this Scene but greatly contribute to thin the Fluid, of which they make a part, and dispose it more to supply the thinner Secretions, of which that by Urine is chief: As also does the Gravity of their Parts, so far as the circulating Force will admit its Influence, more dispose them to go off that way, as it does most of a saline Nature, and such as are a-kin thereunto. After this there can need but little to explain how chalybeate Medicines answer so effectually that known Intention of promoting the menstrual Discharges; for by heating the Blood, that is, rendering it more swift and fluid, the Blood must take up more room

and press harder against the Sides of the Vessels; and by increasing its Quantity of Impulse, it also presses or strikes hardest against whatsoever opposes it, insomuch as sometimes to break the Vessels themselves; and these Effects it is most likely to have, of breaking the Vessels, where their Contortions or Obliquities are greatest, in proportion to their Capacities and Distances from the Heart: Wheresoever therefore the Vessels turn off nearest to Right Angles, and their Capacities are greatest, at such a Place the Blood is most likely to break through; and such is the Contexture of the uterine Blood Vessels.

**MARSHAL:** There are with us divers Officers of this Name; as *Lord or Earl Marshal of England*, whose Office consists chiefly in Matters of War and Arms, as well with us as in other Countries. Also, the *Marshal of the King's House*, whose special Authority is in the King's Palace to hear and determine all Pleas of the Crown, and to punish Faults committed within the Verge, and to hear and judge of Suits between those of the King's Household, &c. There are several other Officers of this Name, as *Marshal of the Justices in Eyre*; *Marshal of the King's-Bench*, who hath the Custody of the *King's-Bench Prison in Southwark*; *Marshal of the King's-Hall*; whose Office is, when the Tables are prepared, to call out both those of the Household, and Strangers, according to their Worth, and decently to place them, &c. Also *Marshal of the Exchequer*, to whom the Court committeth the Custody of the King's Debtors during the Term-time, for securing the Debts: He also assigneth Sheriffs, Escheators, Customers, and Collectors their Auditors, before whom they shall account.

**MARSHALLING** a Coat of Arms (in Heraldry) signifies the due and proper joining of several Coats of Arms in one and the same Shield or Escutcheon, together with their Ornaments, Parts and Appurtenances.

**MARSHALSEA**, is the Court or Seat of the *Marshal of the King's Household*, who formerly perhaps used to sit there in Judgment, or keep his Prison; and is now allowed for the Prison in *Southwark*.

**MARSUPIALIS seu Bursalis**, is a Muscle of the Thigh, so called from its Tendons running through (as it were) a second fleshy Beginning of itself, which Duplication represents a Purse: It is also called *Obturator Internus*; it ariseth broad and fleshy, from that part of the *Os Ilium*, *Ischium*, *Pubis*, and Ligament that is extended in the Great *Foramen* of the two last named Bones internally, and marches transversely in the *Sinus* of the *Ischium*, (fenced on each side by two Processes, the one acute and the other obtuse) where it is externally fleshy, but internally it hath three, sometimes four Tendons passing in so many distinct Furrows in the said *Sinus*, like so many Cords in a Quadruple Pulley, where it meets with the other fleshy beginning, commonly called its *Marsupium*, arising from the above-mentioned Acute and Obtuse Processes, which joining with the said Tendons at their united Insertion to the superior part of the Root of the Great *Trochanter*, near the Implantation of the *Pyriformis*: When this Muscle acteth, its Insertion is directed towards that part of the *Ischium*, over which its Tendons run after the manner of a Pulley, and the *Os Femoris* is thereby turned outwards.

**MARTIAL** *Regulus of Antimony*. See *Regulus*. When any Particles are said to be of a *Martial Nature*



*Nature* in Chemistry or Natural Philosophy, 'tis meant, that they partake of the Nature of Iron or Steel. The Chemists calling Iron *Mars*.

**MARTIAL Law**, is the Law of War, depending upon the King's Pleasure, or his Lieutenant: For the King in time of Peace, never makes any Laws, but by common Consent in Parliament; yet in War he useth absolute Power, inasmuch, that his Word is a Law; but even this Power hath of late Years been invested in the King, or his Generals of the Army by Act of Parliament, and under particular Restrictions too. Read the new Acts of Parliament for punishing Mutineers and Deserters, &c.

**MARTLET**, the Term in Heraldry for a Pigeon, with its Feet erased or torn off; 'tis also the Difference or Mark of Distinction in an Escutcheon for the fourth Brother or Family.

**MARTNETS** in a Ship, are small Lines fastened to the *Leetch* of the Sail, being *Reeved* thro' a Block on the Topmast-head, and so they come down by the Mast to the Deck. Those *Martnets* which belong to the Top-sails are fastened (after the same way) to the Heads of the Top-gallant Masts, but their *Fall* comes down no farther than the Top, when it is haled: The Word is, *Top the Martnets*; i. e. Haul them up. Their Design is, in furling the Sail, to bring that part of the *Leetch* which is next the *Yard-Arm*, close up to the Yard, that so the Sail may furl up the closer.

**MARTYROLOGY**, was anciently a Register kept in the Religious Houses, wherein they set down the Donations of their Benefactors, and the Day of their Deaths, that so on each Anniversary they might commemorate and pray for them: And therefore several Benefactors made this a Condition in their Charters. *Kennet's Paroch. Antiq.*



**MASCLE**, a Term in Heraldry for a Bearing of this Figure: Gules a Chevron Ermin between three *Mascles* Argent, by the Name of Bellgrave. *Guillim* saith, the *Mascle* represents the Mash of a Net, and is an honourable Bearing. A *Mascle* differs from a *Lozenge*, only by being voided.

**MASONRY** [in *Architecture*] a Branch of that Art which consists in the hewing or squaring of Stones, and cutting them level and perpendicular for building; or it is the Art of assembling and joining Stones together with Mortar: Whence there are as many different Kinds of *Masonry*, as there are different Forms and Manners of laying or joining Stones: *Vitruvius* makes mention of seven among the Antients.

1. **Net MASONRY**, consists of Stones squared in their Courses, and so disposed, as that their Joints go obliquely, and the Diagonals are the one perpendicular, and the other level, resembling the Meshes of a Net.

2. **Bound MASONRY**, is that where the Stones are placed one over another like Tiles; the Joints of the Beds being level, and the Mounters perpendicular; so that the Joint that mounts and separates two Stones, fall directly over the Middle of the Stone below.

3. **Greek MASONRY**, is that when after two Stones are laid, each of which makes a Course, another is laid at the End, which makes two Courses; and the same Order is observed throughout the whole Building, which is call'd Double Building.

4. **MASONRY by equal Courses**, is the same as *Bound Masonry*, excepting in this, that Stones are hewn; the same that the Antients call *Isodorum*.

5. **MASONRY by unequal Courses**, is laid of bound Work, and of unhewn Stones; but they are not of the same Thickness, nor is there any Equality observed, except in the several Courses, the Courses themselves being unequal to each other, called by the Antients *Pseudisodorum*.

6. **MASONRY fill'd up in the Middle**, is wrought with unhewn Stone, and by Courses; but the Stones are only set in order as to the Courses, the middle being fill'd up with Stones thrown in at random among the Mortar. This is called *Emplecton* by the Antients.

7. **Compound MASONRY**, is so named because being composed of all the rest: In which the Courses are of hewn Stone, and the middle Places left void and fill'd up with Mortar and Pebbles thrown in together; and after this the Stones of one Course are bound to those of another with Cramp-Irons fastened with melted Lead.

**MASQUE** [in *Architecture*] is certain Pieces of Sculpture, representing some hideous Form, Grotesque, or Satyr's Faces, &c. used to fill up and adorn some vacant Places, as in Freezes, the Panels of Doors, Keys of Arches, &c. but especially in Grottos.

**MASS** [in *Mechanicks*] is the Matter of any Body cohering with it; i. e. moving and gravitating along with it, and is distinguish'd from its Bulk or Volume; which is its Expansion in Length, Breadth, and Thickness.

**MASSE**: This Word is used by the Natural Philosophers to express the Quantity of Matter in any Body; and this Sir *Isaac Newton* saith, he found by most accurate Experiments on *Pendulums*, to be always proportionable to the Weight of Bodies; which is a good Argument to prove the Necessity of allowing a disseminate Vacuum.

**MASSES**, in Painting, are the large Parts of a Picture, containing the great Lights and Shadows.

**MASSETERS**, in Anatomy, are short, thick, tendinous Muscles of the Lower Jaw, produced forwards from the *Os Primum* of the Upper Jaw, and backwards from the *Jugal Bone*; they are connected to the Lower Jaw. They assist the *Temporales* to move it to the Right-side, Left-side, and forward, according to the various Disposition of the *Fibres*.

**MASTER of the Mint**: In the second Year of H. 6. that was the Title of him that now is called the *Warden of the Mint*, whose Office it is to receive the Silver and Bullion that comes to the Mint to be coined, and to take Care thereof.

**MASTER of the Court of Wards and Liveries**; was the chief Officer and Judge of that Court of Wards, kept the Seal of it, and was named and assigned by the King. But this Court and all its Officers, Members, Power, and Appurtenances, is taken away by a Statute made the 12th of Car. 2. c. 24.

**MASTER of the Horse**, hath the Rule and Charge of the King's Stable: This Officer is very honourable, and usually a Nobleman; is mentioned in 39 Eliz. 7. and 1 Edw. 6. 5.

**MASTER of the Posts**, was an Officer of the King's Court that had the appointing, placing and displacing of all such as provided Post-Horses to carry the King's Messages and other Business. He also was to pay them their Wages, &c. This Officer is mentioned in 2 Edw. 6. but now by a Statute made 12 Car. 2. c. 34. he is appointed by the King's Letters Patent, with Rates and Rules prescribed in the said Act.



**MASTER of the Armory**, is an Officer mentioned 29 *Eliz. c. 7.* and hath the Care of the King's Armour in any standing Armories, with Power of putting in and out all interior Officers.

**MASTER of the Jewel House**, is mentioned in 39 *Eliz. c. 7.* and is an Officer of the King's Household of great Credit, being allowed *Bouge of Court*; that is, Diet for himself and the Clerks of the Office, and hath a Lodging in the Court. He hath Charge of all the Gold and Silver Plate used at the King's Table, or belonging to any Officer of Account attending the Court; and of all Plate remaining in the *Tower of London*, as also of Chains and loose Jewels not fixed to any Garment.

**MASTER of the Household**. This Officer is called *Grand Master*, &c. and *Lord Steward of the King's Household*, in 32 *Hen. 8. 39.* And in the first of *Queen Mary*, and ever since, he is called *Lord Steward*, &c. and under him there is a principal Officer called by this Name of the *Master of the Household*.

**MASTER of the Ordnance**, mentioned in 39 *Eliz. 7.* and is a great Officer, to whose Care all the King's Ordnance and Artillery is committed.

**MASTER of the Faculties**, is an Officer under the Archbishop of *Canterbury*, who grants *Licenses and Dispensations*; he is mentioned in the Statute of laying Impositions at Law, of 22, 23 *Car. 2.*

**MASTER of the Wardrobe**, is a great Officer at Court; having his Habitation or Dwelling-House belonging to that Office, called the *Wardrobe*, near *Puddle-wharf* in *London*. He hath the Charge and Custody of all former Kings and Queens Robes remaining in the *Tower of London*, and of all Arras and Tapestry Hangings, Bedding, &c. and the Charge and Delivery out of all Scarlet Liveries belonging to the King or Queen. He is mentioned in 39 *Eliz. 7.*

**MASTER of the Rolls**, is an Assistant to the *Lord Chancellor*, or *Lord Keeper* of the Great Seal of *England*, in the High Court of *Chancery*, and in his Absence, hears the Causes there, and giveth Orders. He is by some called *Clerk of the Rolls*. And he has the disposing of the Offices of the Six Clerks, Clerks of the Petty Bag, Examiners of the Court, and Clerks of the Chapel.

**MASTERS of the Chancery**, are Assistants in *Chancery* to the *Lord Chancellor*, or *Lord Keeper* of the Great Seal, in Matters of Judgment. Of these there are some Ordinary, some Extraordinary; of Ordinary there are Twelve, (whereof the *Master of the Rolls* is accounted one) whereof some sit in Court every Day in each Term, and have referred to them (at the *Lord Chancellor*, *Lord Keeper*, or *Master of the Rolls* Discretion) Interlocutory Orders for stating Accounts, computing Damages, and the like; taking of Oaths, Affidavits, and Acknowledgments of Deeds and Recognizances. The Extraordinary do act in all the Country Ten Miles from *London*, by taking Recognizances and Affidavits, Acknowledgments of Deeds, &c. for the Ease of the Subject.

**MASTICATION**, or Chewing, is an Action, whereby we break and divide the Meat into small Pieces with our Teeth, and mix it with the Spit or *Saliva*, in order to its being the more easily fermented, digested, and turned into Chyle in the Stomach.

**MASTICATORIES**, are Medicines which are designed to provoke Spitting. By some they are called *Apoplegmations*.

**MASTOIDEI**, [of *μαστοειδης*, Gr.] in Anatomy,  
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is the same with *Mammillares*, and are such Processes any where, as are like Breasts or Dugs, which from a broad Basis, end in an obtuse Top, and are shaped like the Teats in a Cow's-Udder.

This Name is given by some Writers to those *Muscles* which bend the Head, proceeding from the Neck-bone and the Breast-bone, terminating in the Process *Mammiformis*. These *Muscles* arise partly tendinous, and partly fleshy, from the Upper Part of the *Os Pectoris*, near half the Clavicle; with two seemingly distinct Originations. Mr. *Cowper* saith, When either of these *Muscles* act, they turn the Face to the contrary side. The Process, or *Apophysis* of the *Os Temporale*, which is in Shape something like the Teats of a Cow, is called by this Name; and so are the Processes of the *Olfactory Nerves*.

**MASTS** of a Ship, are the Main-mast, Main-top-mast, Main-top-gallant-mast, Fore-mast, Fore-top-mast, Fore-top-gallant-mast, Mizzen mast, and Mizzen-top-mast; amongst which, may also be reckoned her Bolt-sprit; all which see.

For the Proportion of Masts, Sir *H. Manwaring* gives these Rules. Whatever the Breadth of a Ship be in Feet, multiply  $\frac{1}{4}$  of that Breadth by 30, the Product is the Length of her *Main-mast* in Yards. Thus if a Ship be 30 Foot at the *Midship-Beam*,  $\frac{1}{4}$  of 30 is 24: Therefore that Ship's *Main-mast* must be 24 Yards, or 72 Feet in Length. Then for its Bigness, he allows an Inch to every Yard in Length; and therefore this *Main-mast* must be 24 Inches through or thick.

The *Fore-mast* of a Ship must be  $\frac{4}{5}$  of the Length of the *Main-mast*, that is, in this Case, 19 Yards  $\frac{1}{5}$ , or 57 Feet  $\frac{3}{5}$ . Thick or through, it must be near 20 Inches.

The *Bolt-sprit* or *Bow-sprit*, is always the same Length and Bigness with the *Fore-mast*. And the *Mizzen-mast* must be just half the Length of the *Main-mast*, and half as thick.

**MATER Dura**, called also *Dura Meninx*, is a Membrane which sticks close to the Skull within, in some Places, and mediately covers both the Brain and *Cerebellum*; it has four Cavities, which supply the Place of the Veins, and come together betwixt the Brain and *Cerebellum*; which Conjunction is called *Torcular*.

**MATER Tenuis**, or *Pia Meninx*, is a Membrane which immediately cloaths the Brain and *Cerebellum*; is extremely full of Sanguinary Vessels, and is design'd, as some think, to keep in the Spirits generated in the Brain and *Cerebellum*, that they fly not away.

**MATERIA Medica**, is whatever is used in the Art of Medicine for the Prevention or Cure of Diseases, whether collected or prepared from Plants, Animals, Minerals, &c. by Chymistry or Pharmacy.

**MATERIA Subtilis**, in the *Cartesian* Philosophy, is what is produced by the grinding or rubbing one against another of the Particles of the second Elements; and so these compose what he calls his first Element. See *Cartesian System of the World*.

**MATHEMATICKS**, originally signifies any Discipline or Learning (*μαθηματις*) but now, 'tis properly that Science which teaches or contemplates whatever is capable, of being numbered or measured, as it is computable or measurable.

And that Part of *Mathematicks* which relates to Number only, is call'd *Arithmetick*: That which relates to Measure in general, whether Length, Breadth, Motion, Force, &c. is called *Geometry*.

*Mathematicks* may be reckon'd either,



1. *Pure, Simple, or Abstracted*; which considers abstracted Quantity, without any relation to Matter or sensible Objects. Or,

2. *Mix'd Mathematicks*; which is interwoven every where with Physical Considerations.

*Mathematicks* also are divided into,

*Speculative*, which proposes only the simple Knowledge of the Thing proposed, and the bare Contemplation of Truth or Falshood: And,

*Practical*, which teaches how to demonstrate something useful, or to perform something that shall be proposed for the Benefit and Advantage of Mankind.

Besides the mention of such Authors as have written on the several Parts of this noble Science, and of which you have an Account under each particular Head, these that follow have written on *Mathematicks* more generally.

*Francisci Laurens Specimina Mathematica, &c.*

*Andreae Tacquet Opera Mathematica, Antw. 1669.*

*The Works of Monsieur Fermat.*

*Dr. Wallis's Mathematical Works, in 3 Vol. Fol. Oxon.*

*De Chales Cursus Mathematicus, 3 Vol. Fol. Ludg. 1674.*

*A Math. Compendium, by Sir Jonas Moore. Lond. 1674. Twelves.*

*Elemens de Mathematiques, ou Principes Generaux de toutes les Sciences qui ont les Grandeurs pour Object, par J. P. a Paris, 1675. 4to.*

*Steph. de Angelis de Infinitis Spiralibus Inversis Infinitis Hyperbolis aliisque Geometricis. Bata-vii. 4to.*

*P. Gregii a St. Vincentio opus Geometr. Quadraturæ Circuli & Sect. Coni. Antw. 1647. Fol.*

*Leybourn's Cursus Mathematicus. Lond. 1690. Fol.*

*Simon Stevin les Oeuvres Mathematiques. Leyden, 1694. Fol.*

*Clavius's Opera Mathematica. Fol.*

*Mr. Hayes's Fluxions. Lond. 1704. Fol.*

*Foster's Miscellanies. Lond. 1659. Fol.*

*Pappus Alexandrinus's Math. Collect. per Commandinum. Bononiæ, 1650. Fol.*

*Sir Jonas Moore's System of Mathematicks, 2 Vol. Lond. 1681. 4to.*

<i>Cavallerii Trigonometria.</i>	} Bononiæ {	1643	} 4to.
<i>Direktorum generale Uranometricum.</i>		1632	
<i>Exercitationes Geometricæ.</i>		1647	
<i>Geometria Indivisibilis Continuorum.</i>		1635	

*Barrow's Lectiones Geometricæ & Opticæ. Lond. 1669. 4to.*

*Sturmius's Mathesis Enucleata. 2 Vol. 8vo.*

——— *Juvenilis. 2 Vol. 8vo.*

*Veteres Mathematici. Paris. 1693. Fol.*

*Math. Collections in English, from Galileo. Lond. 1661. Fol.*

*Hook's Micrographical Lections & Opera Posthum.*

*Scotii Cursus Mathemat. Herbipoli. 1661.*

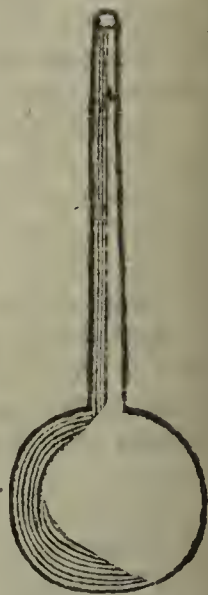
*Herigone's Cursus Mathematicus. Paris. 1644. 8vo.*

*Mr. Blondell's Cours de Mathematique, pour Mr. le Dauphin. Paris. 1683. 4to.*

*Ozanam's Cours de Mathematique. 8vo.*

**MATHEMATICAL Horizon**, is the same with **True Horizon**. See **Horizon**.

**MATRASS**, or *Bolt-head*, is a long strait-necked Vessel of Glass, frequently used by the Chymists in Distillations; and when they are fitted to the Nose of an Alembick, they are called *Receivers*, because they receive the Matters which the Fire forces over the Helm or Head of the Still. They are of this Figure. And when one of these is by its Neck luted well into the Neck of another, they call it a double Vessel, which is used for the Circulation of Spirits, and for the opening or subtilizing of any Body by a long Digestion.



**MATRICE** [with *Dyers*] a Term which they apply to the five Colours, from whence all the rest are derived and composed; these are the *Black, White, Blue, Red, and Sallow or Root Colour*.

**MATRICES** [with *Letter-Founders*] are those little Pieces of Brass or Copper, at one End of which are engraven *en creux*, or dent-wise, the several Letters or Characters used in composing Books.

**MATRICES** [for Coining] those Pieces of Steel in Form of Dies; on which those several Figures, Arms, Characters, Legends, &c. with which the Species is to be stamped, are engraven.

**MATRICULA**, anciently was the Word for a Register. Thus in the Church there was the *Matricula Clericorum*, which was a List or Catalogue of the officiating Clergy; and *Matricula Pauperum*, a Catalogue of the Poor to be received; and to this Day, being registred as a Member in the University of Oxon, is called *Matriculation*.

**MATRIX**; the same that *Uterus*.

**MATRIX** of a Tree or Plant, is the same with what the Botanists call *Cor*; which see.

**MATRIX** } any thing which serves for the  
**MATRICE** } Place of the Generation of a Body, whether it be organical, as the *Matrix* or Womb of Female Animals for the Production of the Species, or inorganical, as those are of Vegetables, Metals, or Minerals.

**MATROSSES**, are Soldiers in the Train of Artillery, next below the Gunners: Their Duty is to assist the Gunners in Traversing, Spunging, Firing, and Loading of Guns, &c. They carry Firelocks, and march along with the *Store-Wagons*.

**MATTER**, or *Body*, is an impenetrable, divisible, and passive Substance, extending into Length, Breadth and Thickness. This, when consider'd in general, remains the same in all the various Motions, Configurations and Changes of Natural Bodies, being capable of putting on all manner of Forms, and of moving according to all manner of Directions and Degrees of Velocity.

The Quantity of Matter in any Body, is its Measure, arising from the joint Consideration of the *Magnitude* and *Density* of that Body: As if any Body be twice as *dense* as another, and take up *twice the Spate*, 'twill be four times as great. This Quantity of Matter is best discoverable by *Weight*, to which 'tis always proportionable; as the excellent Sir *Isaac Newton*, by most accurate Observations on Pendulums, found true by Experience.

Dr. *Woodward*, in his *Essay towards a Natural History of the Earth*, Part 5. asserts *Matter* to be originally and really very different; being at its first Creation



Creation divided into several *Ranks, Sets* or *Kinds* of *Corpuscles*: That all the *Corpuscles* which are of the same *Kind* or *Set*, agree in every thing, and are most exactly like unto one another in all respects: But those that are of *different Kinds*, differ from one another every way, as well in *Matter* or *Substance*, in *Specifick Gravity*, in *Hardness*, in *Flexibility*, and in several other ways, as in *Bigness* and *Figure*. And he supposes, that from the various *Composures* and *Combinations* of these *Corpuscles* together, happen all the Varieties of the Bodies formed out of them; and all their Differences in Colour and outward Appearance, in Taste, in Smell, in Hardness, in Specifick Gravity, and in all other respects.

There is one universal Matter, common to all Bodies, an extended, divisible, and impenetrable Substance.

This Matter being in its own Nature but one, the Diversity in Bodies must necessarily arise from somewhat else; and since there could be no Change in Matter at Rest, there is a Necessity of Motion to discriminate it; and for that Motion, also, to have various Tendencies.

Motion, in many Parts of Matter, appears manifest to Sense; but how it came by this Motion, is disputed. The ancient *Corpuscularians*, who acknowledged no Author of the Universe, were reduced to make it inherent in Matter; and consequently coeval therewith; but since local Motion, or an endeavour at it, is not included in the Nature of Matter, which is as much Matter when at rest, as when in Motion; and since the same Portion of Matter, may from Motion be reduced to Rest; and after it hath continued at rest, as long as other Bodies do not put it out of that State, may, by external Agents, be moved again; I am of Opinion, that the Origin of Motion in Matter, is from God; as, also, the Laws by which it operated in bringing the World to its present Frame; so that local Motion seems to be the Principal amongst second causes, and the grand Efficient of all that happens in Nature: For tho' Bulk, Figure, Rest, Situation and Texture, concur to the Phænomena of Nature; yet, in Comparison of Motion they seem, in many Cases, to be Effects, and in others, little better than Conditions or Requisites, which modify the Operation, that one part of Matter, by Virtue of its Motion, hath upon another; as in a Watch, the Number, the Figure, and Correspondence of the Wheels and other Parts, are requisite to the performing the Office of a Watch; but, till these Parts are actually put in Motion, all their other Properties remain inefficacious. Thus, also, a Key, tho' it were too big, or too little, or its Shape unfit for that of the Cavity of the Lock, would not perform its Office, tho' put into Motion; yet, let its Size and Figure be never so fit, unless actual Motion intervene, it will never lock or unlock; as, without the like actual Motion, a Knife, or Razor, will not actually cut, how much soever their Shape, and other Qualities, fit them for that Action, So Brimstone, what Disposition of Parts soever it has to be turned into Flame, would never be kindled, unless some actual Fire, or other vehemently and variously agitated Matter, put the sulphureous *Corpuscles* into a very brisk Motion.

These two principles, Matter and Motion, being established, it will follow, that Matter must be actually divided into Parts; and that each of the Primitive Fragments, or other distinct and entire Masses, must have two Attributes, its own Magni-

tude or Size, and its own Figure or Shape. And since Experience shews, that this Division of Matter is frequently made into insensible Particles; we may conclude, that the minutest Fragments, as well as the largest Portions of the universal Matter, have likewise, their peculiar Bulk and Shape: For being a finite Body, its dimensions must be terminated, and measureable; and tho' it may change its Figure, yet it will necessarily have some Figure or other. We must therefore, admit three essential Properties of each entire Part of Matter, *viz*, Magnitude, Shape, and either Motion or Rest; the two first of which may be called inseparable Accidents; because Matter being extended, and yet finite, it is physically impossible that it should be destitute of some Bulk and Determinate Shape.

Whether these Accidents may not be called the Modes, or primary Affectations of Bodies, to distinguish them from the less simple Qualities, Colours, Tastes, &c. that belong to Bodies upon their Account; or whether, with the *Epicureans*, they may not be called the Conjuncts of the smallest Parts of Matter, I shall now consider: But the Schools teach, that there are in natural Bodies, many real Qualities, and other real Accidents, which not only are no Modes of Matter, but real Entities distinct from it. Now, Accident is, by *Logicians*, used in two several Senses; sometimes it is opposed to the fourth Predicable, or Property, and is then defined, that which may be present or absent, without the Destruction of the Subject; as a Man may be sick or well, and a Wall white or black; and yet the one be still a Man, and the other a Wall; and this, in the Schools, is called *Accidens predicabile*, to distinguish it from what they call *Accidens prædicamentale*, which is opposed to Substance: And as Substance is commonly defined to be a Thing that subsists of itself, and the *Substratum* of Accidents; so an Accident is said to be *id cujus esse est inesse*; and therefore *Aristotle*, who usually calls Substances simple Entities, most commonly calls Accidents Entities of Entities; these requiring the Existence of some Substance wherein to reside, as in their Subject of Inhesion: And, because *Logicians* make it the discriminating Mark of Substance from Accident, that it cannot exist in another Thing, as in its Subject of Inhesion, it is requisite to know, that, according to them, a Thing is in a Subject, which, however it be in another Thing, is not in it as a Part, and cannot exist separately from the Thing wherein it is; as a white Wall is the Subject of Inhesion of the Whiteness we see in it; which same Whiteness, tho' it be not in the Wall as a Part of it; yet cannot, according to our *Logicians*, exist any where out of the Wall, tho' many other Bodies may have the like Degree of Whiteness. This premised, it will not be hard to discover the Absurdity of the Opinion, just mention'd, of real Qualities and Accidents; the School Doctrine about which, appears to be either unintelligible or manifestly contradictory. For, speaking in a physical Sense, if they will not allow these Accidents to be Modes of Matter, but Entities really distinct from it, and, in some Cases, separable from all Matter, they make them, indeed, Accidents in Name, but represent them under such a Notion as belongs only to Substances; the Nature of a Substance consisting in this, that it can subsist of itself, without being in any Thing else, as in a Subject of Inhesion; so that to tell us, a Quality, or other Accident, may consist without a Subject, is to allow it the true Nature of Substance. Nor could



could I ever find it intelligibly made out, what these real Qualities are, that they deny to be either Matter, or Modes of Matter, or immaterial Substances. When a Bowl is in Motion or at Rest, that Motion or Rest, or globular Figure of the Bowl, is not nothing, yet not Part of the Bowl; whose whole Substance would remain, tho' it wanted any one of these Accidents; and to make them real physical Entities. is, as if, because we may consider the same Man sitting, standing, running, thirsty, hungry, &c. we should make each of these a distinct Entity, as we give some of them distinct Names; whereas, the Subject of all these Qualities is but the same Man, considered with Circumstances, which may make him appear different in one Case, from what he appears in another. And, we must here observe, that not only diversity of Names, but even Diversity of Definitions, does not always infer a Diversity of physical Entities in the Subject, whereto they are attributed, For it happens in many physical Attributes of a Body, as it does where a Man, who is a Father, a Husband, a Master, a Prince, &c. may have a peculiar Definition in each of these Capacities; and yet the Man consider'd in himself, is but the same Man, who, in respect of different Capacities or Relations to other Things, is called by different Names, which conclude not so many real and distinct Entities in the Person thus variously denominated.

Besides the Properties of Matter hitherto known, Sir *Isaac Newton* has discovered a new one, *viz.* That of Attraction; or that every Particle of Matter has an attractive Power, or a Tendency towards every other Particle; which Power is strongest in the Point of Contact, and suddenly decreases, in so much that it acts no more at the least sensible Distance; and at a greater Distance is converted into a repellent Force, whereby the Parts fly from each other. On this Principle of Attraction, he accounts for the Cohesion of the Particles of Bodies, otherwise inexplicable: For he takes occasion to observe, That all Bodies seem to be compounded of hard Particles, even Light itself, and all other the most volatile of Fluids; in so much, as Hardness may be esteem'd a Property of all uncompounded Matter; at least the Hardness of Matter stands on as good a foot as that of its Impenetrability, all the Bodies we know of, being either hard themselves, or being capable of being hardened. Now if Compound Bodies be so hard, as we find some of them, and yet are very porous, and consist of Parts which are only laid together; the simple Particles, which are void of Pores, and were never yet divided, must be much harder. Now such hard Particles being heaped together, can scarce touch one another in more than a few Points, and therefore must be separable with much less Force than is requisite to break a solid Particle, whose Parts touch in all the Space, without any Pores or Interstices to weaken their Cohesion: How then should such very hard Particles, only laid together, and touching only in a few Points, stick together, and that so firmly as they do, without the Assistance of something that causes them to be attracted or press'd towards each other.

The same great Author observes further, That the smallest Particles may cohere by the strongest Attractions, and compose bigger Particles of weaker Virtue; and many of these may cohere and compose bigger Particles, whose Virtue is still weaker, and so on for divers Successions, until the Progression end in the biggest Particles; on which the Operations in Chymistry, and the Colours of na-

tural Bodies depend; and which, by cohering, compose Bodies of a sensible Magnitude, if the Body is compact, and bends or yields inward to Pressure, without any sliding of its Parts; it is hard and elastic, returning to its Figure with a Force arising from the mutual Attraction of its Parts. If the Parts slide upon one another, the Body is malleable or soft; if they slip easily, and are of a fit Size to be agitated by Heat, and the Heat is big enough to keep them in Agitation, the Body is fluid; and if it be apt to stick to Things, it is humid: And the Drops of every Fluid affect a round Figure by the mutual Attraction of their Parts, as the Globe of the Earth and Sea affects a round Figure by the mutual Attraction of its Parts of Gravity.

Again; since Metals dissolved in Acids, attract but a small Quantity of the Acid, their attractive Force reaches but to a small Distance. Now, as in Algebra, where affirmative Quantities cease, there negative ones begin; so in Mechanics, where Attraction ceases, there a repulsive Virtue must succeed: That there really is such a Virtue, seems to follow from the Reflections and Inflections of the Rays of Light, the Rays being repelled by Bodies in both these Cases, without the immediate Contact of the reflecting or inflecting Body. The same thing seems also to follow from the Emission of Light; a Ray, as soon as shaken off from a shining Body by the vibrating Motion of the Parts of the Body, and got beyond the reach of Attraction, being driven away with exceeding great Velocity; for that Force which is sufficient to turn it back in Reflection, may be sufficient to emit it; it seems also to follow from the Production of Air and Vapour: The Particles, when they are shaken off from the Body by Heat or Fermentation, as soon as they are beyond the reach of the Attraction of the Body, receding from it, and also from one another, with great Strength, and keeping at a Distance, so as sometimes to take up above a Million of times more space than they did before in the Form of a dense Body; which vast Contraction and Expansion seems unintelligible, by feigning the Particles of Air to be springy and ramous, or rolled up like Hoops, or by any other means than a repulsive Power. The Particles of Fluids, which do not cohere too strongly, and are of such a Smallness as renders them most susceptible of those Agitations, which keep Liquors in a Fluor, are most easily separated and rarified into Vapour; and, in the Language of the Chymists, they are volatile, rarifying with an easy Heat, and condensing with Cold. But those which are grosser, and so less susceptible of Agitation, or cohere by a stronger Attraction, are not separated without a stronger Heat, or perhaps not without Fermentation; and these last are the Bodies which Chymists call fixed; and being rarified by Fermentation, become true permanent Air; those Particles receding from one another with the greatest Force, and being most difficultly brought together, which upon Contact cohere most strongly. And because the Particles of permanent Air are grosser, and arise from denser Substances than those of Vapours, thence it is that true Air is more ponderous than Vapour; and that a moist Atmosphere is lighter than a dry one, Quantity for Quantity. From the same repelling Power it seems to be, that Flies walk upon the Water without wetting their Feet, and that the Object-Glasses of long Telescopes lie upon one another without touching; and that dry Powders are difficultly made to touch one another so as to stick together, unless by melting them, or wetting them with Water, which by exhaling



exhaling may bring them together; and that two polish'd Marbles, which by immediate Contact stick together, are difficultly brought so close together, as to stick.

He further observes, That all things considered, it seems probable God, in the Beginning, formed Matter in solid, massy, hard, impenetrable, moveable Particles, of such Sizes, Figures, and with such other Properties, and in such Proportion to Space, as most conduceth to the End for which he formed them; and that these Primitive Particles being Solid, are incomparably harder than any porous Bodies compounded of them; even so very hard, as never to wear, and break in Pieces; no ordinary Power being able to divide what God himself made one in the first Creation. While the Particles continue entire, they may compose Bodies of one and the same Nature and Texture in all Ages; but shou'd they wear away, or break in Pieces, the Nature of Things depending on them would be changed: Water and Earth, composed of old worn Particles, and Fragments of Particles, would not be of the same Nature and Texture now, with Water and Earth compos'd of entire Particles in the Beginning; and therefore that Nature may be lasting, the Changes of Corporeal Things are to be placed only in the various Separations, and new Associations and Motions of these permanent Particles; compound Bodies being apt to break, not in the midst of solid Particles, but where those Particles are laid together, and only touch in a few Points.

It seems farther, That these Particles have not only a *Vis Inertiae*, accompany'd with such passive Laws of Motion, as naturally result from that Force, but also that they are moved by certain active Principles, such as is that of Gravity, and that which causeth Fermentation, and the Cohesion of Bodies. These Principles are to be consider'd, not as occult Qualities suppos'd to result from specific Forms of Things, but as general Laws of Nature, by which the Things themselves are form'd; their Truth appearing to us by Phænomena, tho' their Causes are not yet discovered.

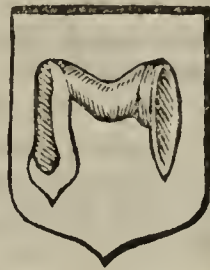
**MATTER** in Deed, and *Matter of Record*, are Terms in Law, which are said to differ thus: *Matter in Deed*, seems to be nothing else but a Truth to be proved, tho' not by any Record; and *Matter of Record*, is that which may be proved by some Record. For Example: If a Man be sued to an *Exigent*, during the Time he was in the King's Wars; this is *Matter in Deed*, and not *Matter of Record*: And therefore he that will alledge this for himself, must come before the *Scire Facias*, before Execution be awarded against him; for after that, nothing will serve but *Matter of Record*; that is, some Error in the Process appearing upon Record.

**MATTS** on board a Ship, are a kind of broad thick Clouts, wove out of spun Yarn, Sinnet, or Thrums; and are used to preserve the Main and Fore-Yards from galling against the Masts at the Tyes, and at the Gunnel of the Loof: Also they serve to keep the Clew of the Sail from galling there; as also to save the Clews of the Fore-sail from doing so at the Beak-head and Boltsprit.

**MATURITY**, the just Ripeness of any Fruit; and by Analogy, the Arrival of any thing to its just Degree of Perfection.

**MATURATION**, is the Action of growing ripe, or the Tendency of any Fruits towards Maturity or Ripeness.

**MAUNCH**: The Figure of an ancient Sleeve of a Coat, is so called by the Heralds, and is born in many Gentlemens Escutcheons; as in the Earl of *Huntington's*, in those of the *Coniers*, &c.



**MAUND**, was anciently a Measure of Capacity with us, being a kind of great Basket or Hamper, containing 8 Bales, or 2 Fatts. See the Book of Rates, *Fol.* 3.

**MAXILLA Superior**, the Upper Jaw-bone: this constitutes the inferior and lateral Parts of the Orbit of the Eye, and comprehends also the Bones of the Nostrils, Palate, and Upper Row of Teeth. It hath, according to *Diemerbrook*, twelve Bones belonging to it, six on each side. The first is called the *Os Jugale*, and is of a triangular Form, and posited at the external Angle of the Eye. The second is called the *Foramen lacrymale*, and is a thin pellucid small Bone, placed in the internal Angle of the Eye, and gives a Passage to that Liquor which makes the Tears. 'Tis near this *Foramen* that the *Abscesse*, which the *Greeks* call *Ægilops*, and we *Fistula lacrymalis*, usually happens. The third is a thin pellucid Bone, placed between the two former, and within the Orbit of the Eye, and which is continued with the fungous Bones of the Nostrils. The fourth is a large Bone, constituting the greatest Part of the Cheek and Palate, and receiving into it the Upper Teeth by their proper Caverns: It hath an eminent conspicuous *Foramen*, or Hole, placed under the Orbit of the Eye, and transmitting to the Face a Branch of the third Pair of Nerves. It hath also another *Foramen* at the hinder part of the *Dentes incisorii*; and then there go up two *Foramina*, with a bony Partition between them, one to each Nostril. The fifth is a thin, hard, small, oblong Bone, approaching to a square Figure; and this, with its Partner on the other side, constitutes the Bridge, or protuberant Bone of the Nose. The sixth Bone forms, with its Fellow, the bony part of the Palate, or Roof of the Mouth. *Fallopian*, *Columbus*, and some others, add to these a thirteenth Bone, which they call *Vomer*, and place it between the Palate and *Os sphaeroides*; and will have it like a kind of *Septum*, to divide the lower Parts of the Nostrils. And *Vesalius* reckons the two *Ossa spongiosa* among these Bones of the *Superior Maxilla*.

**MAXILLA Inferior**, is the lower or moveable Jaw: This contains all the Lower Teeth. It hath two Processes on each side; of which, the Foremost is thin and large, and ends in a kind of Point, to which the Tendon of the Temporal Muscle is firmly knit, and this is called *Corona*: The other is obtuse, and lies more backwards, and is join'd by a Cartilage to the Neck; and its Part, by which it adheres, they call *Condylus*: It hath four *Foramina* design'd to transmit the aforesaid Processes.

**MAXILLARIS Glandula** [in *Anatomy*] a considerable Gland of the conglomerate kind, situated on the Inside under the Lower Jaw-Bone, near the *musculus digastricus*. It discharges itself by several Branches of Ducts which form one Trunk, which passes under the *Mylohyoideus*, and meets with that of the other side within the Fore-teeth of the Lower Jaw, having distinct Orifices with *Papillæ* on each side *Frænum Linguae*.

**MAXIMIS** and *Minimis*. The Mathematicians call that Method whereby a Problem is resolved,



which requires the greatest or least Quantity attainable in that Case, *Methodus de Maximis & Minimis*.

Of this see *Hon. Faber*, at the End of his *Synopsis Geometrica*, where you have a great Variety of Problems of this kind. See also *Ozanam's* Preface to his *Dictionnaire Mathematique*; the Marquis d'*Hospital* his *Analyse des Infiniment Petits*, Sect. 3, &c. In the *Acta Erud. Lips.* A. D. 1683. p. 122. there is also a Method of determining *Maxima & Minima*, by one *D. T.* chiefly applicable to the drawing of Tangents to Curves: And in the same Book, and for the Year 1684. p. 467. you have a Method of the famous *Mr. Leibnitz*, for the same Purpose, according to his *Calculus Differentialis*. See also the Seventh Book of *Mr. De la Hire's Conick Sections*, in Latin; and Chap. 7. of *Niewentiit's Analysis Infinitorum*. There is also printed in the First Volume of *Des Cartes's Geometry*, a Method of *Huddes* for finding the *Maxima & Minima*, p. 137.

The following Account of this Method, was communicated to me by *Mr. Humphrey Ditton*, a Person very skilful in these Matters; and late Master of the New Mathematical School in *Christ's Hospital*.

### PROBLEM.

To determine any Flowing Quantity in an Equation propos'd, to an Extreme Value.

Tho' there are various excellent Methods for the doing of this, yet there is nothing that seems so clear and natural, and is really so general, so quick and easy, as that which the Doctrine of *Fluxions* furnishes us withal.

To solve the Problem in any Case that can be propos'd, is only to make a just Application of this General Rule, viz.

Having put the Equation into Fluxions, let the Fluxion of that Quantity (whose Extreme Value is sought) be suppos'd = 0; by which Means all those Members of the Equation in which it is found, will vanish, and the remaining ones will give the Determination of the Maximum or Minimum desired.

### DEMONSTRATION.

Every *Maximum* or *Minimum*, is in its own Nature a *Stable Quantity*: To determine therefore any Flowing Quantity to a *Maximum* or *Minimum*, is to make it (instead of a Flowing) a Permanent one; but the *Fluxion* of a Permanent Quantity is equal to Nothing. From whence the Reason of the Rule is sufficiently clear.

Let us illustrate this by some Examples. *Ex. gr.*

Suppose  $bbx - y y x + c y x - d^3 = 0$ , where  $y$  and  $x$  are Flowing Quantities, and  $y$  is to be determined to an Extreme Value: Then  $bb\dot{x} - 2\dot{y} y x - y y \dot{x} + c y \dot{x} + c \dot{x} y = 0$ , and making  $\dot{y} = 0$ ,  $bb\dot{x} - y y \dot{x} + c y \dot{x} = 0$ , and  $yy - c y = bb$ ; from which Quadratick Equation  $y$  may be determin'd.

Let  $rx - \frac{rxx}{q} - \dot{y}y = 0$ , which is the Equation of an Ellipse, where the *Latus Rectum* =  $r$ ,

the *Latus Transversum* =  $q$ ; the *Abscisse* =  $x$ , and the *Ordinate* =  $y$ ; then we have

$r\dot{x} - \frac{2rx\dot{x}}{q} = 2y\dot{y} = 0$ , from whence  $qr = 2rx$ , and  $x = \frac{q}{2}$ ; which Value of  $x$  substituted in the Equation of the Curve, gives  $\frac{rq}{4} = yy$ , and so  $y = \sqrt{\frac{rq}{4}}$  = the *Semi-Conjugate*.

Again, Suppose  $yyu - dyz - ccd = 0$ , where  $y, z, u$ , are all Flowing Quantities; and  $y$  is to be determin'd to an *Extremum*. Now in all such Cases, where the Equation will involve the Fluxions of so many different Flowing Quantities, we must endeavour by convenient Substitutions to expunge some of them, that we may have no more than one sort of Fluxions left to deal with; of which the Equation may be clear'd by ordinary Division. And I think this Method, which I'll propose in the first place, to be a very easy and general one in order to this End. The Equation is  $yyu - dyz - ccd = 0$ ; from whence  $2y\dot{y}u + yy\dot{u} - d\dot{y}z - d\dot{z}y = 0$ , and putting  $\dot{y} = 0$ ,  $yy\dot{u} - d\dot{z}y = 0$ . Now to throw out these Fluxions in the last Equation, we need only substitute the Value of either of them from the second Equation, where we find  $\dot{u}$  (*ex. gr.*) =  $\frac{d\dot{y}z + d\dot{z}y - c y \dot{y} u}{yy}$

wherefore  $yy\dot{u} - d\dot{z}y = d\dot{y}z + d\dot{z}y - 2yy\dot{u} - d\dot{z}y = d\dot{y}z - 2y\dot{y}u = 0$ ; wherefore  $d\dot{z} - 2y\dot{u} = 0$ , which is the Equation desired.

Suppose  $yyx - zyx - m = 0$ , and  $y$  to be determined to an *Extremum*. Then  $2y\dot{y}x + yy\dot{x} - \dot{z}yx - z\dot{y}x - zyx = 0$ , and making  $\dot{y} = 0$ ,  $yy\dot{x} - x\dot{z}y - z\dot{y}x = 0$ ; but  $\dot{z} = \frac{2yy\dot{x} + yy\dot{x} - z\dot{y}x - z\dot{y}x}{yx}$ , wherefore sub-

stituting this in the Room of  $\dot{z}$  in the former Equation, we have  $yy\dot{x} - 2y\dot{y}x - yy\dot{x} + z\dot{y}x + z\dot{y}x - z\dot{y}x = 0$ ; that is,  $z\dot{y}x - 2y\dot{y}x = 0$ , and  $zx - 2yx = 0$ .

But *Mr. Niewentiit* furnishes an Expedient for this Purpose also in the Seventh Chapter of his *Analysis Infinitorum*: He considers the Flowing Quantities in the Equation, as the Ordinates of so many several Curves, which have one common *Abscissa*; then substituting the Values of the Fluxions of these Ordinates (gotten by the general Property of all Curves) he brings all the Fluxions to one Expression. *Ex. gr.* In the Equation above,  $yyu - dyz - ccd = 0$ , where we had  $yy\dot{u} - d\dot{y}z = 0$ , let  $y, u, z$  be conceiv'd to be the Ordinates of three several Curves, whose common *Abscisse* let =  $x$ , and let the *Subtangent* belonging to  $u$  be =  $n$ , and that for  $z$  be =  $l$ ; then  $\dot{u} = \frac{y\dot{x}}{n}$  and  $\dot{z} = \frac{z\dot{x}}{l}$ ,

wherefore  $\frac{yyu\dot{x}}{n} - \frac{dyz\dot{x}}{l} = 0$ ; that is,  $lyu - dzn = 0$ , the Equation for  $y$  determined to an *Extremum*. 'Tis true, this Equation appears something different from that which was deduced by the former Process: There the Equation was



$dz - 2yu = 0$ , and here 'tis  $lyu - dzn = 0$ ; but that these Equations are exactly the same, is thus easily discovered. Because  $\dot{u} = \frac{v\dot{x}}{n}$ , and

$\dot{z} = \frac{z\dot{x}}{l}$ , therefore  $\dot{u} : \dot{z} :: \frac{n}{l} : \frac{z}{u}$ ; from whence

$l : n :: z\dot{u} : u\dot{z}$ , but (by what went before)  $\dot{u} = \frac{\dot{y}z + d\dot{z}y - 2y\dot{y}u}{yy}$ , wherefore  $l : n ::$

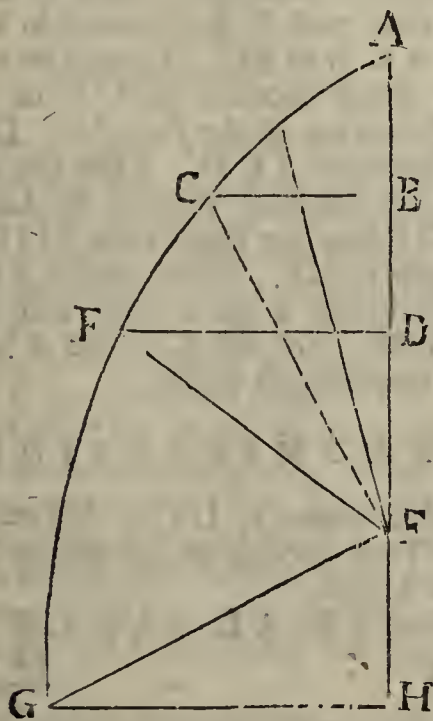
$\frac{d\dot{y}zz + d\dot{z}zy - 2y\dot{y}zv}{yy}$ ,  $v\dot{z}$ ; from hence

in Mr. *Neiwentit's* Equation, viz.  $lyu - dzn = 0$ , substituting these Quantities in the Room of  $l$  and  $n$ , to which they are proportional, we have  $\frac{yuzzd\dot{y} + uzzy\dot{z} - uuz2yy}{yy}y - duz\dot{z}$

$= 0$ , or dividing all by  $uz$ , and multiplying by  $yy$ , and rejecting Contradictories, we have  $dz y \dot{y} - 2y y \dot{y} u = 0$ ; that is,  $dz - 2yu = 0$ . Q. E. D.

These Examples may serve to illustrate a Rule which is in itself very plain and obvious.

As for the Use and Application of the Doctrine *de Maximis & Minimis*, perhaps it may be as Useful and Noble a one as any, to shew how from hence all sorts of Curves may be cut at Right Angles, and consequently the Invention of the Tangents is to be performed.



Let A C G be any Curve whose Vertex is A, Axe AH, its Ordinates ED, CB, GH: Let any Point, as F, be taken in the Axe at Liberty, and from thence the Lines FC, FE, FG be drawn to the Curve.

Let AF =  $n$ , AB, AD, AH =  $x$ , HF =  $n + x$ , BF, FD =  $n - x$ , ED, BC, GH =  $y$ , FC, FE, FG =  $z$ . The Point F being taken any where at liberty, 'tis evident, that when any Line, as FC, FG, &c. is coincident with FE, which I imagine to be a Normal to the Curve in the Point E, from the same Point F; that then the intercepted Line, FB, FH, &c. is coincident with the Subnormal FD, and consequently upon the determining of an Extremum, the Invention of a Tangent naturally follows.

To form the General Equation that is to serve in this Business, we have, from the Rectangular

Triangle FBC,  $zz = nn - 2nx + xx + yy$ ; or on the other Side F, from the Triangle GHF,  $zz = xx - 2nx + nn + yy$ ; or for an Extremum,  $2x\dot{x} - 2n\dot{x} + 2y\dot{y} = 0$ : In which Equation, if in the room of  $2y\dot{y}$ , we substitute its Value from the Equation of the Curve, the Subnormal will be discovered.

Ex. gr. Suppose the Curve were an Hyperbola, then  $2y\dot{y} = r\dot{x} + \frac{2rx\dot{x}}{q}$ : Therefore

$2x\dot{x} - 2n\dot{x} + r\dot{x} + \frac{2rx\dot{x}}{q} = 0$ , and  $2n\dot{x}$

$= 2x\dot{x} + r\dot{x} + \frac{2rx\dot{x}}{q}$ , and  $n = x + \frac{r}{2} \frac{rx}{q}$

$= FA$ ; wherefore FD (the Subnormal) =  $\frac{r}{2} \frac{rx}{q}$  Q. E. I.

Suppose the Curve a Circle, in which Case  $2y\dot{y} = 2r\dot{x} - 2x\dot{x}$ ; then proceeding as before, we have  $2n\dot{x} = 2r\dot{x}$ , and  $n = r$ ; and therefore FD =  $r - x$ ; which shews that F is ever in this Curve, the Centre itself. In the common

Parabola,  $r\dot{x} = 2y\dot{y}$ , and therefore  $n = \frac{r}{2} + x$ , and so FD =  $\frac{r}{2}$ . But 'tis not only in these Co-

nick Sections, but in any other Curve whatsoever, that from this general Equation by a due Substitution of the Value of  $2y\dot{y}$ , the Tangent, or (which is all one in effect) the Subnormal will be discover'd.

MAXIMS, are a kind of Propositions which have passed for Principles of Science, under the Name of *Maxims* and *Axioms*, and which being self-evident, have been supposed innate.

MAXY, is the *Tin-miners* Term for a Weed, as they call it, of the *Marchasite* kind, from whence *Maxy* seems to be a Corruption. When the Load or Vein of Oar degenerates into this or any thing else that is not Tin, they call it *Weed*.

MEAN Axis, in Opticks. See Axis.

MEAN Diameter, in Gauging, is a Geometrical Mean between the Diameters at Head and Bung in any close Cask.

MEAN and Extreme Proportion. See Extreme and Mean Proportion.

MEAN in Law, signifies the Middle between two Extremes, and that either in Time or in Dignity. As in the first, his Action was Mean betwixt the Dissension made to him and his Recovery, that is, in the Interim, (or, as we say, in the meantime) Of the second, there is Lord-mean or mesne, and Tenant-mean. See Mesne.

MEAN Motion, or mean Longitude of the Sun, in the Ptolemaick Hypothesis, is an Ark of the Ecliptick, reckon'd from the beginning of Aries to the Line of the Sun's Mean Motion, accounting according to the Order of the Signs. And 'tis also not unusual to call the

MEAN Motion of the Sun, in the old Astronomy, the Distance (accounted on in the Ecliptick, from the beginning of Aries) of the Sun from the Line of his Mean Motion. See Line of the Sun's Mean Motion.

MEAN or middle Proportional, between any two Lines or Numbers, is that which hath the same Proportion to a third Term that the first bears to it.

Thus

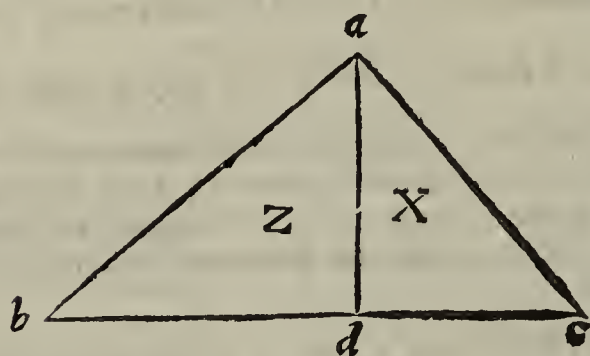


Thus 8 is a *mean Proportional* between 2 and 32, because  $2 : 8 :: 8 : 32$ . And the three Numbers in this Case are thus expressed 2. 8. 32 :: That is, two, eight, and thirty-two, are in *continual Proportion*; for the same *Proportion* is continued from the Middle or Second Term to the Third, as was between the First and Second: Therefore 'tis the very same thing, as if the Middle Term had been put down twice. Now, because when Four Numbers are *proportional*, the Rectangle of the middle Terms is equal to that of the Extremes, it must be so here: But here the two middle Terms being the same Number, they will make a Square; so that when three Numbers are in *continual Proportion*, the Square of the middle Term is equal to the Rectangle of the Extremes; and that middle Term is call'd a *mean Proportional* between the other two.

### PROPOSITION.

In a Right-angled Triangle,

The Perpendicular ( $ad$ ) is a *mean Proportional* between the Segments of the Hypothenuse ( $bd$  and  $dc$ .)

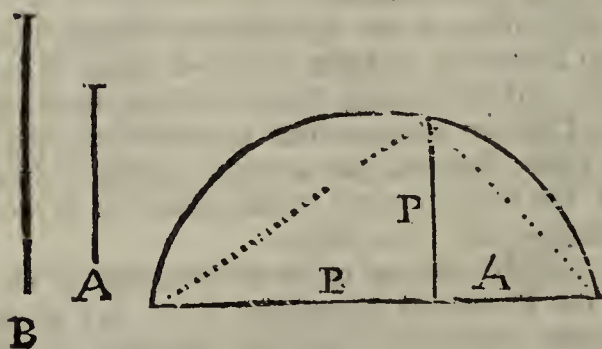


That is, as  $bd : ad :: ad : dc$ ; and therefore the Square of  $ad$  is equal to the Rectangle between  $bd$  and  $dc$ .

For the Triangles  $cda$  and  $adb$ , being similar, 'twill be as  $cd : da :: da : db$ ; and consequently  $\square da = \square bdc$ .

### PROBLEM.

To find a Mean Proportional to two given Lines, A and B.



Put A and B both into one Line, then bisect the whole Line; make the Point of Bisection the Centre of a Semi-circle, and then erect the Line P perpendicular to the two given Lines, at their Point of Union: I say, the Line P is the *Mean Proportional* sought.

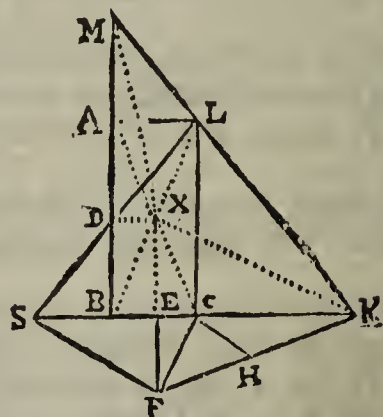
For  $B : P :: P : A$ , by the last Proposition.

To find a Mean Proportional between any Two Numbers,

Multiply the Numbers into one another, and extract the Square Root of the Product: Of which see more under *Logarithms*, and the *Use of Logarithms*, Numb. 11 and 12.

To find Two Mean Proportionals between Two given Lines, AB and BC.

This famous Problem (which is the same as the *Duplication of the Cube*) may be resolved and demonstrated by means of the Conchoid of *Nicomedes*; and would be geometrical, if that were a Geometrical Curve.



Join the given Lines AB and BC together at Right Angles, and bisect each in the Points D and E: Complet the Rectangle ALBC, and draw LD till it meet with CB produced to S: Then will  $SB = AL$  or to BC. From E let fall a Perpendicular, which produce till CF be equal to AD, which will cut off the Part EF. Draw then FS, and parallel to it CH. Then (by *Coroll. 1. Prop. 2. of the Conchoid*) through the Legs of the Angle KCH draw the Right Line FHK, so that HK be equal to CF. Draw also the Right Line KLM, producing it till it meet with BA also produced in M. So will CK and AM be the two *Mean Proportionals* sought.

### DEMONSTRATION.

Let MA be called  $b$ , LC or AB  $= eb$ , and BC  $= c$ . Then because of the Similar Triangles MAL and LCK,

AM. LC or AB :: AL or AC. CK

$$b . eb :: c . \frac{ebc}{b} \text{ or } ec.$$

Wherefore  $ec = CK$ . Also MA. AD :: SC. CK.

$$b . \frac{eb}{2} :: 2c . ec.$$

(Because if you halve one Consequent, you must double the other Antecedent.) And SC. CK :: FH. HK (because CH is parallel to SF) Wherefore MA. AD :: FH. HK. HK is equal to AD or  $\frac{1}{2}eb$  (as was taken above) wherefore FH must be equal to MA or  $b$ . And consequently MD = FK (for both in this Notation are  $b + \frac{1}{2}eb$ .) And the Square of each will be  $bb + ebb + \frac{1}{4}eebb$ ; that is,  $= FE + \square EK$ , (by 47 e. 1. Eucl.) And to these equal Quantities adding the Squares of DX and EC, each of which is  $\frac{1}{4}cc$ . Their Sum, viz.  $\square MD + \square DX$  (i. e.  $\square MX$ ) will be  $bb + ebb + \frac{1}{4}eebb + \frac{1}{4}cc$ ; which also is equal to the Sum of these  $\square EF + \square EC$  (i. e.  $\square FC$ , which was  $=$  to  $AD = XE$  by the Construction



See 9 *H.* 3. 51 *H.* 3. 12 *H.* 7. &c. wherein it is enacted, that eight Pound *Troy Weight* of Wheat, gathered from the middle of the Ear, and well dried, should make one Gallon of *Wine Measure*, and that there should be but one Measure for Wine, Ale, and Corn throughout the Kingdom. See 14 *Ed.* 3. and 15 *Rich.* 2. But Custom in time hath prevailed against this, having altered *Measures* as well as *Weights*; no other but *Troy Weight* being appointed by our Laws to be used. (See 14 and 17 of *E.* 3.) we having now three different Measures; viz. one for Wine, one for Ale, and Beer, and one for Corn. See the Table of them under *Measures*.

Only let me add further from Mr. *John Ward's* Arithmetick, p. 34. That tho' the common Wine Gallon sealed at *Guild-Hall* in *London*, by which all Wines, Brandies, Spirits, Strong waters, Mead, Perry, Cyder, Vinegar, Oyl, Honey, &c. are measured and sold, is supposed to contain 231 Cubick Inches; and from thence, the *Tierce* will contain 9702 Cubick Inches, the Hogshead 14553, the Punchion 19404, the Butt or Pipe 29106, and the Tun 58212. Yet it hath been accurately experimented, that the Wine Gallon at *Guild-Hall* doth hold but 224 Cubick Inches; as indeed Dr. *Wybaird* had before taken Notice of in his *Tactometry*, p. 289. But yet in *May* 25, 1688, when an Experiment was made for the Lord Mayor of *London* and the Commissioners of the Excise, in Confirmation of the Truth of the Account above, of the Capacity of the Standard Gallon; viz. that it is but 224 Cubick Inches; yet it was then thought fit to continue the common *supposed* Contents of 231 Cubick Inches for the Wine Gallon, and that all Computation in Gauging should be made from thence; and so I suppose it yet stands.

The *Beer* and *Ale* Gallon is larger than the *Wine* Gallon, in Proportion to the Excess of the common Pound *Averdupois* above the true Pound *Troy*: that is, as 12. 231 : : so  $14\frac{1}{2}$  to  $281\frac{1}{2}$ , which is very near the Cubick Inches in the Ale Gallon. The Ale Quart contains  $70\frac{1}{2}$  Cubick Inches; the Gallon will be 282.

Dry Measure seems to stand still in Proportion to the old Wine Gallon of 224 Cubick Inches. The common received Content of the Corn Gallon being  $272 \frac{1}{4}$ . for as  $12. 14. \frac{1}{2} \div :: 224. 272. \frac{1}{2}$ . and yet by an Act of Parliament made *A. D.* 1697, it is appointed, that every round Buschel with a plain and even Bottom, being made 18 Inches and  $\frac{1}{2}$  wide throughout, and 8 Inches deep, shall be esteemed a legal Winchester Buschel, according to the Standard in his Majesty's Exchequer. Now a Vessel thus made, will contain 2150.42 Cubick Inches; and consequently the Corn Gallon can be but  $268 \frac{4}{7}$  Cubick Inches.

MEASURES. I thought it would be a very acceptable Thing to the Reader, to see in one View, an Account of the Ancient and Present Measures of several Parts of the World: Which therefore I have here given him, as I occasionally collected them from the best Authors.

Join the given Lines  $AB$  and  $BC$  in a Right Angle, as before, and compleat the Rectangle, drawing the Diagonal to find the Point  $X$ , and producing  $BA$  and  $BC$  both ways towards  $M$  and  $K$ ; for then fix a Ruler on the Centre  $L$ , and then return it forward and backward, till you find by the Compasses  $MX$  and  $XK$  are equal; and then  $AM$  and  $CK$  are the Lines sought.

Another Method for which, *Eutocius* also mentions, which seems more practical; which is, To make a Semi-circle on *AC* the Diagonal of the Rectangle, then the moveable Ruler is placed forwards and backwards till *LM* (by the Compasses) be found equal to *NK*, and that will give the Points *M* and *K*, and consequently the Lines *AM* and *CK* required.

How to find Two *Mean Proportionals* by help of the *Cissoid* of *Diocles*, and by two *Parabola's*, (which was *Menechmus's* Way) see *Sturmius Mathesis Enucleata*, Book 2. Prop. 21. *Consect. & Scholium. Des Cartes* doth the same thing by help of one *Parabola* only; see his *Geometry*, p. 91. and as many as you please by help of a *Curve Line* generated after a peculiar way; which see in p. 67, 68, of his *Geometry*. Much more of this Nature you have in *Slusius's Mesolabium*.

MEASURES of Capacity: These (with us) both liquid and dry, were first made from Troy Weight.



# A TABLE of the *Foreign Measures*, carefully compared with the *English*.

				Suppose an <i>English</i> Foot divided into 1000 Equal Parts: those here mentioned are in Proportion to it, as follows.	The <i>English</i> Foot divided into Inches and Decimal Parts of an Inch.
London	—	—	Foot	1000	0.12.0
Paris	—	the Royal	Foot	1.068	1.00.8
Amsterdam	—	—	Foot	.942	0.11.3
Brill	—	—	Foot	1.103	1.01.2
Antwerp	—	—	Foot	.946	0.11.3
Dort	—	—	Foot	1.184	0.02.2
Rynland or Leyden	—	—	Foot	1.033	1.00.4
Lorain	—	—	Foot	.958	0.11.4
Mechlin	—	—	Foot	.919	0.11.0
Middleburg	—	—	Foot	.991	0.11.9
Stratsbourg	—	—	Foot	.920	0.11.0
Bremen	—	—	Foot	.964	0.11.6
Cologn	—	—	Foot	.954	0.11.4
Frankford ad Manam	—	—	Foot	.948	0.11.4
Spanish	—	—	Foot	1.001	1.00.0
Toledo	—	—	Foot	.899	0.10.7
Roman	—	—	Foot	.967	0.11.6
On the Monument of	{ <i>Cestucius</i> <i>Statilius</i> }		—	.972	0.11.7
Bononia	—	—	Foot	1.204	1.02.4
Mantua	—	—	Foot	1.569	1.06.8
Venice	—	—	Foot	1.162	1.01.9
Dantzick	—	—	Foot	.944	0.11.3
Copenhagen	—	—	Foot	.965	0.11.6
Prague	—	—	Foot	1.026	1.00.3
Riga	—	—	Foot	1.831	1.09.9
Turin	—	—	Foot	1.062	1.00.7
The Greek	—	—	Foot	1.007	1.00.1
Paris Foot, according to Dr. Bernard	—	—	—	1.066	
Universal	—	—	Foot	1.089	
Old Roman	—	—	Foot	.970	
Bononian Foot of M. Auzout	—	—	—	1.140	
Lyon	—	—	Ell	3.976	3.11.7
Bologn	—	—	Ell	2.056	2.00.8
Amsterdam	—	—	Ell	2.269	2.03.2
Antwerp	—	—	Ell	2.273	2.00.2
Rynland or Leyden	—	—	Ell	2.260	2.03.1
Frankford	—	—	Ell	1.826	1.09.9
Hambourg	—	—	Ell	1.905	1.10.8
Leiping	—	—	Ell	2.260	2.03.1



## The TABLE Continued.

<i>Lubeck</i>	—	—	Ell	1.908	1.09.8
<i>Noremburg</i>	—	—	Ell	2.227	2.03.3
<i>Bavaria</i>	—	—	Ell	.954	0.11.4
<i>Vienna</i>	—	—	Ell	1.053	1.00.6
<i>Bononia</i>	—	—	Ell	2.147	2.01.7
<i>Dantzick</i>	—	—	Ell	1.903	1.10.8
<i>Florence</i>	—	—	Brace or Ell	1.913	1.11.0
<i>Spanish or Castile</i>	—	—	Palm	0.751	0.09.0
<i>Spanish Vare or Rod, which is Four Palms</i>				3.001	1.00.0
<i>Lisbon</i>	—	—	Vare	2.750	2.09.0
<i>Gibraltar</i>	—	—	Vare	2.760	2.09.1
<i>Toledo</i>	—	—	Vare	2.685	2.08.2
<i>Naples</i>	—	—	{ Palm	0.861	0.09.6
			{ Brace	2.100	2.01.2
			{ Canna	6.880	6.10.5
<i>Genoa</i>	—	—	Palm	0.830	0.09.6
<i>Milan</i>	—	—	Calamus	6.544	6.06.5
<i>Parma</i>	—	—	Cubit	1.866	1.10.4
<i>China</i>	—	—	Cubit	1.016	1.00.2
<i>Cairo</i>	—	—	Cubit	1.824	1.09.9
Old { <i>Babylonian</i>			{ Cubit		1. 6. $\frac{24}{1000}$
{ <i>Greek</i>	—				1. 6. $\frac{12}{1000}$
{ <i>Roman</i>					1. 5. $\frac{426}{1000}$
<i>Turkish</i>	—	—	Pike	2.200	2.02.4
<i>Persian</i>	—	—	Arafh	3.197	3.02.3

## The Hebrew or Jewish Long-Measures.

	Feet.	Inches.	Parts.
Cubit	1	09	888
Span, or Half-Cubit	0	10	944
Palm	0	03	648
Digit	0	00	912
Fathom, 4 Cubits, or	7	03	552
Ezekiel's Reed, 6 Cubits, or	10	11	328
Pole or Canna, 8 Cubits, or	14	7	104
Schænus, Chain or Line	145	$\frac{22}{1000}$	
Sabbath-Day's Journey, 2000 Cubits, or 3648 Feet.			
Eastern-Mile, 4000 Cubits, or 7296 Feet.			
Parasang, 12000 Cubits, or 24888 Feet, or $4\frac{1414}{10000}$ Miles.			
Stadium, $\frac{1}{30}$ of a Parasang, or 400 Cubits.			
A Day's Journey, 8 Parasangs, or 96000 Cubits, or 33,16 Miles.			



## The Hebrew Measures of Capacity.

	Solid Inches.	W. Gal.	Pints	Solid Inches.
<i>Epba</i> , or <i>Bath</i>	1747.7	7	4	15.2
<i>Corus</i> , or <i>Choner</i> , is	174.77	75	5	7.0
<i>Seab</i> , $\frac{1}{3}$ of an <i>Epba</i>	582.5	2	4	3
<i>Hinn</i> , $\frac{1}{6}$ of an <i>Epba</i>	291.25	1	2	1.5
<i>Homer</i> , $\frac{1}{10}$ of an <i>Epba</i>	174.77	0	6	0.5
<i>Cab</i> , $\frac{1}{18}$ of an <i>Epba</i>	97.03	0	3	10
<i>Log</i> , $\frac{1}{72}$ of an <i>Epba</i>	24.25	0	0	24.2
To which add the <i>Syrian Metretes</i> , or } <i>Congius Romanus</i>	207.06		7	$\frac{1}{8}$

## The Grecian Long-Measures.

*Schoenes*. This some will have to contain 60, some 30, others 32, and others 40 Furlongs.

*Parasang*, is the same with the *Hebrew Parasang*.

*Dolich*. This some will have to contain 24 Furlongs; but the common Account is 12.

*Hippicon*, containing Four Furlongs.

*Diaulus*, Two Furlongs.

*Plethron*. This some make an Acre, as *Plutarch*; others  $\frac{1}{2}$  of a Furlong, or 100 Feet, as *Suidas*; others 10000 Feet, as *Hesychius*; and some make it 100 Furlongs. But *Suidas* seems rightest in stating it 100 Foot.

*Pygon*. This *Hesychius* supposes the Length from the Elbow to the Fingers Bent, which some call *Palmipes*; that is, a Foot and a Palm, or 20 Fingers Breadth.

*Pygme*, is the Length from the Elbow to the End of the Hand, when the Fist is closed, and is two Inches shorter than the *Pygon*.

*Orthodoron*. Some make this a Palm, others a Span; but 'tis shorter by a Finger's Breadth than the Span, or Greater Palm.

*Lichas*, is usually reckon'd the Length or Span between the End of the Thumb and of the Forefinger, when both are separated and extended; and therefore is less than the *Orthodoron* by a Finger's Breadth. Some will have it the same with *Dichas*, which *Cowper*, in his Dictionary, says, is but Eight Fingers Breadth; but the former Account seems truest.

*Palest*, the same with *Doron*, is the Lesser Palm, being 4 Fingers Breadth, or 3 Inches English.

But there is great Uncertainty in these Accounts.

## The Measures of Capacity, were,

1. The *Kypsele*. This *Scapula* reckons a Corn-measure, and is supposed to contain 6 Attick Medimnos.

2. *Medimnos*, both Attick and Georgick, contained 48 Chænixes, or 72 Sextaries. But because the Georgick Chænix was larger than the Attick, there must be some Difference between them.

3. *Metretes*. Some render this by *Cadus*, and some by *Amphora*; the latter is wrong, for the *Amphora* is another Measure. This *Legat*, and some others, will have equal to the Attick Medimnos. This was not the Syrian Metretes, mentioned *John* 2. 6. for that was the same with the *Congius Romanus*.

4. *Amphora*, or *Amphoreus*. This was a Georgick Measure, and was half the Medimnos or *Metretes Georgicus*, as some say; others (as *Schrevelius*) will have it an Attick Measure, and to contain 3 Urns.

5. *Modion* was not what we call a Bushel, but a Measure much less. *Alsted* computes it to contain 8 Attick Chænixes, or 12 Sextaries: Others make it hold 16 Sextaries; and others a Pint less than our Peck.

6. *Chous*, *Chus* and *Choas*, was of two sorts: the Attick held 6 Attick Sextaries, and the Georgick Chous 9 Georgick Sextaries.

7. *Chænix*. This some take for the Measure of Servants Food for one Day. The Attick Chænix, 'tis probable, held about one Attick Sextary and an half; and the Georgick 2 and  $\frac{1}{4}$  of such. Others say, that the latter held but barely 2 Attick Sextaries. Some also mention a *Bilibral*, *Quadrilibral*, and *Quinquelibral Chænix*. So that 'tis hard to determine any thing certain as to these Matters.

8. *Sextarius*, or *Xesta*. This some make 2 Kotyles, or  $\frac{1}{2}$  of the Attick Chous. This Measure, say some Authors, would hold 20 Ounces of Water, others 24: Others are so exact as to tell you, that it held exactly 13 Ounces, 7 Pennyweights, and 18 Grains *Troy*: Some say it held a Pint and an half of our Measure; and others will have it but half a Pint.

9. *Kotyle Attick*, is the Half Sextary. Some make this equal to the Roman *Hemina*; and then the Roman and the Attick Sextaries will be the same. This the Romans wrote *Cotyle*.

10. *Tetacton*.



10. *Tetacton*. This was a Liquid Measure, being a fourth Part of the Attick Sextary, and therefore called also *Quartarius*. But the Georgick Sextary contained  $2\frac{2}{3}$  of the Georgick Tetacton.
11. *Oxybaph*. This in the Attick Measure was the Twelfth Part of the *Chænix*; but in the Georgick the Eighth.
12. *Kyath*, in Latin *Cyathus*: One and half of this was an *Oxybaph*.
13. *Coucha* was the Half of a *Kyath*.
14. *Mystrum*, the Half of the *Coucha*.
15. *Cheme*. One *Mystrum* contained  $2\frac{1}{2}$  of the *Cheme*.

### A TABLE of Grecian Exotick Measures, compared with the Attick.

1. *Achana Persica*. This, according to *Hesychius*, was a Corn-measure, and contained 7 Kypseles, and 3 *Medimni*.
2. The Syrian *Metretes*: Which our very learned Dr. *Cumberland*, Bishop of *Peterborough*, hath proved to be the same with the *Congius Romanus*, and holds of our Measure 7 Pints, and  $\frac{1}{8}$  or 207.06 solid Inches. This is what we translate (but wrongly) a Firkin, *John* 2. 6.
3. *Artaba Persica*. This, from the Authority of *Herodotus*, Lib. 1. Pag. 49, may be concluded to hold 3 *Chænicas* more than the Attick *Medimnus*. St. *Jerom*, on *Isaiah*, Chap. 5. saith, that this Measure held 20 *Modii*.
4. *Kyprus*, or *Cyprus*, was the same with the Attick *Medimnus*.
5. *Artaba Ægyptica*. This *Epiphanius* makes the same with the Attick *Medimnus*; as also was, saith he, the Median *Artaba*: But *Fannius* and *Legat* make it but  $3\frac{1}{3}$  *Modii*.
- Medimnus Kyprius* { *Saluminca*, } contained { 5 *Modii*.  
                          { *Papho*,        } { 4 *Modii*, and 1 *Chous*.
7. *Collathum Syrium*, was the same Measure with the Pontick *Modius*, and was double to the Common *Modius*. And the like Quantity did the
8. *Ponticus Cyprus* contain also, as *Epiphanius* saith.
9. *Subitha Syria*, held 22 Attick Sextaries.
10. *Mares Ponticus*, held (according to *Epiphanius*) 20 Alexandrian Sextaries; which how much different from the Attick I know not.
11. *Kophinus*. This was a Boetick, both Liquid and Dry; and *Legat* saith it held 3 *Congii*.
12. *Modius Cyprius*, is a Measure containing 17 Attick Sextaries.
- 13 { *Kamfaces*, } each a Measure of twelve Sextaries.  
    { *Tetarpe Laconices*, }
14. *Dadix*, a Boetick Measure, containing 6 *Chænicas*.
15. *Aphin*, an Ægyptian Measure of 4 *Chænicas*: And of the same Measure doth *Hesychius* make the *Topium* to be; but he tells us not where the *Topium* was used.
16. *Caphita*, a Persian Measure of two Attick *Chænicas*. To this was the *Mares* equal; and some say was a Measure used in *Boetia*.
17. *Inion*. This with the Ægyptians, saith *Legat*, was the Word for the Sextary; and, according to *Epiphanius*, held just two Pound of Oyl.
18. *Elenius*, the same with the *Tetarton*, or one Quarter of a Sextary.
19. *Gabenon*, the same with the *Oxybath* or *Aretabule*.
20. *Alabastron* was a Measure containing a Pound of Oyl.

### A TABLE of English Long-Measures.

Inch.										
3	Palm.									
9	3	Span.								
12	4	$1\frac{1}{3}$	Foot.							
18	6	2	$1\frac{1}{2}$	Cubit.						
36	12	4	3	2	Yard.					
45	15	5	$3\frac{3}{4}$	$2\frac{1}{2}$	$1\frac{1}{4}$	Ell.				
60	20	$6\frac{2}{3}$	5	$3\frac{1}{3}$	$1\frac{2}{3}$	$1\frac{1}{4}$	Pace.			
72	24	8	6	4	2	$1\frac{3}{4}$	$1\frac{1}{5}$	Fath.		
198	66	22	$16\frac{1}{2}$	11	$5\frac{1}{2}$	$4\frac{2}{3}$	$3\frac{1}{5}$	2 <sup>3</sup>	Pole.	
7920	2640	880	660	440	220	176	132	110	40	Furl.
63360	21120	7040	5280	3520	1760	1408	1056	830	320	8 Mile.



## A TABLE of Square Measures.

Inches sq.								
144	Feet sq.							
1296	9	Yards sq.						
3600	25	2,77	Paces sq.					
39204	272,25	30,25	10,39	Poles sq.				
1568160	10890	1210	435,6	40	Roods sq.			
	43560	4840	1742,4	160	4.	Acres sq.		
		3097600	1115136	102400	2560	640	Mile.	

*Dry Measures of Capacity*, are raised from the Gallon containing 8 Pints, which should be contained in  $272\frac{1}{4}$  Cubick Inches, and should hold of pure Running or Rain-Water, 9 Pound, 13 Ounces, 12 Drams and  $\frac{1}{2}$ , *Averdupois* Weight: so that to have a true Gallon for *Dry Measure*, you must make a Cubick Vessel that shall have all the Sides 6 Inches, and  $\frac{48}{100}$  Parts of an Inch Square. Or if you would weigh with *Averdupois* Weight, 9 Pound, 13 Ounces, and  $12\frac{1}{2}$  Drams of clean Running Water.

## A TABLE of Dry Measures.

Pints.									
8	Gallons.								
16	2	Pecks.							
64	8	4	Bushels.						
128	16	8	2	Strikes.					
256	32	16	4	2	Carnock or Coom				
512	64	32	8	4	2	Seem or Quarter.			
3072	384	102	48	24	12	6	Way.		
5120	640	320	80	40	20	10	12	Last.	
1 lb	8 lb	16	64	128	256	512	3072	5120	Troy.
14 $\frac{2}{3}$	7 lb	14	56	1 C.	2 C.	4 C.	24 C.	40 C.	Averd.

*Liquid Measure*, is either of *Wine*, *Ale*, or *Beer*.

The *Wine Gallon* contains 231 Cubical Inches, and should hold of pure Running Water 8 Pound, 1 Ounce, 11 Drams *Averdupois*; or 9 Pound, 10 Ounces,  $1\frac{1}{4}$  Penny-weight *Troy*; or a Cubick Vessel of 6 Inches, and 1300 Parts every way.

A TABLE for *Wine-Measure*, *Honey*, *Oyl*, &c.

							Pints	
						Galls	8	
						Rundl.	18	144
					Barrels.	$1\frac{3}{4}$	$31\frac{1}{2}$	252
				Terces.	$1\frac{3}{4}$	$3\frac{1}{2}$	42	336
		Hogsh.	$1\frac{1}{2}$	2	$3\frac{1}{2}$	63	504	
	Punch.	$1\frac{1}{3}$	2	$2\frac{2}{3}$	$4\frac{2}{3}$	84	672	
Butt, or Pipe	$1\frac{1}{2}$	2	3	4	7	726	1008	
Tun.	2	3	4	6	8	14	252	2016



The *Beer* or *Ale* Gallon holds 282 solid Inches, and weighs of pure Water 13 Pound, 3 Ounces  $1\frac{4}{10}\frac{6}{10}$  Parts *Averdupois*; therefore the Cubick Vessel ought to be 6 Inches, and 5500 Parts of an Inch each way, to find this Gallon.

A solid Foot contains 1728 solid Inches; that is, 6.128 Gallons; and a *Hogshead* contains 10.287 solid Feet; or if in round Numbers you allow 10 Feet to be in a *Hogshead*, then the *Butt* will contain 20, and the *Tun* 40 Feet.

### A TABLE for Beer Measure.

				Pints.
				Gallons.
				8
				72
				144
				288
				576

### A TABLE for Ale Measure.

				Pints.
				Gallons.
				8
				64
				128
				256
				512

A Degree, or  $\frac{1}{360}$  part of the Circuit of the Earth, according to

Dr. Bernard, is  $\begin{cases} 73\frac{1}{4} \text{ English Miles, of 5000 Foot in a Mile.} \\ 67\frac{1}{2} \text{ Catholick Miles.} \\ 66\frac{1}{3} \text{ Arabick Miles.} \end{cases}$

Mr. Norwood,  $69\frac{1}{2}$  English Miles, or 367200 Feet.

Mr. Picard, ————— 365184 Feet.

MEASURE, in Musick, is a Quantity of the Length and Shortness of Time, either with respect to natural Sounds, pronounced by the Voice, or artificial, drawn out of musical Instruments: Which Measure is adjusted in Variety of Notes, by a constant Motion of the Hand or Foot, down or up, successively and equally divided; so that every down and up is called a *Time* or *Measure*, whereby the Length of a *Semi-breve* is measured, which is therefore termed, the *Measure-Note*, or *Time-Note*.

MEASURE [in Geometry] Euclid defines it to be a Quantity, which being repeated any Number of times, becomes equal to another; but this only answers to the Idea of an arithmetical Measure; therefore it may be more aptly defin'd to be a certain Quantity assumed, as One or Unity, to which the Ratio of other homogeneous or similar Quantities is express'd.

MEASURE of a Line, is any Right Line taken at pleasure. The modern Geometricians use a *Decempeda* or Perch divided into 10 equal Parts called Feet, and these Feet are again subdivided into 10 Digits, and the Digits into 10 Lines, &c.

MEASURE of a Number [in Arithmetick] is such a Number as divides another, without any Remainder, or leaving any Fraction, as 3 is the Measure of 9.

MEASURE of a Figure or Plain Surface [in Geometry] is a Square whose Side is of any determinate Length.

MEASURE of a Solid, is a Cube whose Sides are of any Length at pleasure.

MEASURE of an Angle [in Trigonometry] is an Arch described from the Vertex in any Place between its Legs.

MEASURE of Velocity [in Mechanics] is the Space passed over by the moving Body in any given time: therefore, in order to measure a Velocity, you must divide the Space into as many equal Parts as the Time is conceived to be divided into. The Quantity of Space answering to such an Article of Time, is the Measure of the Velocity.

MEASURE of the Mass [in Mechanics] is the Measure of the Quantity of the Matter, that is, its Weight; it appearing plain, that all the Matter which coheres and moves with a Body, gravitates with it; and it being found by Experiments, that the Gravities of homogeneal Bodies are in proportion to their Bulk, hence, let the Figure be what it will, the Weight will be the same while the Mass continues the same; that is, its absolute Weight; for as to its Specifick, that varies as the Quantity of the Surface varies.

MEATUS



**MEATUS Cysticus** [in *Anatomy*] a biliary Duct, about the bigness of a Goose Quill; which is about two Inches distant from the Gall Bladder, is join'd to the *Meatus Hepaticus*; and these together form the *Ductus Communis*.

**MEATUS Auditorius**, the Auditory Passage, begins from the *Concha*, and winds towards the inward part of the Ear, and is cloathed with a thin Skin as far as the Brim of the *Tympanum*, or Drum of the Ear: Its use is to receive the Sound, and to convey it easily, but yet truly and so effectually to the *Tympanum*; within this Cavity is the *Ear-wax*, or *Cerumen*.

**MEATUS Urinarius**. See *Urethra*.

**MECHANICAL Affections**, are such Properties in Matter as result from their Figure, Bulk, and Motion.

**MECHANICAL Causes**, are such as are founded on mechanical Affections.

**MECHANICAL Philosophy**, is the same with the *Corpuscular*, which endeavours to explicate the *Phænomena* of Nature from *Mechanical Principles*; i. e. from the *Motion*, *Rest*, *Figure*, *Position*, *Magnitude*, &c. of the minute Particles of Matter. It was also that which the most ancient of the *Phænician* and *Greek* Philosophers have adhered to for the Explication of the *Phænomena* of Nature; and these made use originally of no other *Principles* than the Consideration of *Empty Space*, the *Doctrine of Atoms*, and in particular, the *Gravitation of Bodies*. These silently attributed the *Cause of Gravity* to something which was plainly distinct from Matter; and this *Cause* our most modern natural Philosophers, in their Enquiries into Nature, did by no means take into Consideration. They have happily avoided aiming at any *Hypothesis* to explain the *Phænomena* of natural Effects, and leaving the *Philosophy of Causes* to Metaphysicks, they have rightly considered that it is the chief End, Design, and Business of natural Philosophy to consider *Effects*; and by reasoning upon them and their various *Phænomena*, to proceed regularly at last to the *Causes* of Things; and especially to the Knowledge of the *First Cause*. And certain it is, that all true Progress and Proficiency in this Kind of natural Philosophy, if it don't immediately lead us to the Knowledge of the *First Cause*, yet will surely bring us still nearer and nearer to it; and therefore is a most noble, excellent, and valuable Study. *Vid. Newt. Opt. Lat. Ed. p. 315.*

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**MECHANICAL Solution** of a Problem in Mathematics, is either when the Thing is done by repeated Tryals, or when the Lines made use of to solve it are not truly geometrical. Thus the Method of *Nicomedes*, *Eratostrhes*, *Pappus* and *Vieta*, for finding two mean Proportionals; and that of *Nicodemus* and *Dinostratus*, for dividing an Angle into any Parts assigned, by means of the *Quadratrix*, is *Mechanical*: Because the former is done by repeated Tryals, and the latter by the means of a Curve that is not truly geometrical.

**MECHANICKS**, [*μηχανική*, Gr.] *Dr. Wallis* defines to be the Geometry of Motion; and is a mathematical Science which shews the Effects of *Powers*, or moving Forces, so far as they are applied to Engines; and demonstrates the Laws of Motion, &c. 'Tis also commonly taken for those *Handy-crafts*, which require as well the Labour of the Hands, as the Study of the Brain.

The Principle on which all mechanick Power depends, will be easily understood by the Resolution of this Problem.

*Any Body, as A, with its Celerity C, being given; and also another Body, as B: 'Tis required to find the Velocity necessary, to make the Moment, or Quantity of Motion in B, to be equal to the Moment of A, the given Body.*

Now since the *Moment* of any Body is equal to the *Rectangle* under the *Celerity* and the *Quantity* of Matter; as you will find in the *Laws of Motion*, (see the Word *Motion*.) You need only make as B to A :: so is C to a fourth Term, which will be c, the *Celerity* proper to B, so that its *Moment* shall be equal to that of A.

And from hence it follows, That any Body, though never so small, may have a *Moment* equal to that of any other Body, tho' never so great, which shall be moved with any given *Celerity*.

Wherefore in any *Machine* or *Engine*, if the *Velocity* of the *Power*, be made to the *Velocity* of the *Weight* :: reciprocally as the *Weight* is to the *Power*; then shall the *Power* always sustain or move the *Weight*.







If  $Qp$  be drawn perpendicular to the Thread  $Np$ , so as to cut the Plane  $pG$ , in a Line parallel to the Horizon: And if the Weight  $p$  be supposed to lie only on the two Planes  $pQ$ , and  $pG$ , the Weight will press these Planes perpendicularly with the Forces  $pH$ , and  $HN$ : That is, it will press the Plane  $pQ$ , with  $Np$ ; and the Plane  $pG$ , with  $HN$ .

Wherefore, if  $Qp$  be supposed to be taken away, so that the Weight  $p$  may stretch the Thread  $Np$ ; then, because the Thread now sustaining the Weight, supplies the Place of the Plane  $Qp$ , the Thread will be stretch'd by the Force  $Np$ , which before pressed on the Plane  $pQ$ .

Wherefore the Tension of this oblique String, to the Tension of the other perpendicular on  $Np$ : is as  $pN$  is to  $pH$ .

And consequently, if the Weight  $p$  be to the Weight  $A$ : in a *Ratio*, compounded of the reciprocal *Ratio* of the least Distances of the Threads  $AM$ , and  $pN$ , from the Centre of the Wheel, and of the direct *Ratio* of  $pH$ , to  $pN$ , the Weight will be in *Æquilibrio*, as any one may soon try.

Hence 'tis plain, that the Weight  $p$  lying on those two oblique Planes, is in the Nature of a Wedge within the Parts of a Cloven Body; and consequently the Forces of the Wedge and Beetle may from hence also be known.

For the Force with which the Weight  $p$  presses the Plane  $pQ$ , is to the Force with which either by its own Gravity, or by the Stroke of the Beetle it is impelled according to the Line  $Hp$  in that Plane, :: as  $pN$  is to  $pH$ ; and to the Force with which it presses the other Plane  $pG$ : : as  $pN$ ,  $NH$ .

And since the Screw is nothing but a Wedge forced by a Lever, its Power or Force may by this Method be easily calculated.

Wherefore (adds the excellent Author:) This Corollary is of most extensive Use, since all Mechanicks depend upon it.

**MECHANICK Powers**, (as they call them) are Six, viz. The *Balance*, the *Lever*, the *Wheel*, the *Pulley*, the *Wedge*, and the *Screw*; to some or other of which, the Force of all *mechanical* Inventions must necessarily be reduced. See those Words.

**MECONIUM** [*μικόνιον*, Gr.] properly is an Opiate, or the condensed Juice of Poppies. Also the Excrements of a *Fœtus*, which stick to the Intestines after the Birth, are improperly so called, from the Blackness of their Colour, like to that of Poppy Juice.

The *Opium* which we have in *England*, *France*, &c. is only a *Meconium*, made by expressing the Juice of the Oriental Poppies, which is thickened a little by Evaporation, and then wraps up in Leaves to be sold here: But the *Turks*, &c. keep the Tears of their Poppies, or the true *Opium*, to themselves, and will not vend them abroad.

**MEDALLIONS**, are large Medals coined, not as current Money, but on some special extraordinary Occasion.

**MEDALS**, are Pieces of Metal like Money, stamp'd or coined upon some extraordinary Occasion, to perpetuate the Memory of some great and eminent Person, or of some considerable Victory, or other publick Benefit to a Nation, or People.

They divide *Medals* into *Ancient* and *Modern*; and they account ancient, all such as were coined between the third and ninth Age of Christ. The Modern are such as have been made within these last 3 or 400 Years.

Of the ancient Medals, the most ancient are the *Greek*; and the *Consular Medals*, are the most ancient of the *Latin* ones.

**MEDIAL Alligation**. See *Alligation Medial*.

**MEDIANA Linea** [in *Anatomy*] a Line or Seam running down the middle of the Tongue, and dividing it into two equal Parts; but not so effectually, but that the Blood Vessels of the one side communicate with those of the other.

**MEDIANA Vena**, is the Middle Vein in the bending of the Cubit, betwixt the Cephalick and Basilick; it is safely opened, because there's neither Nerve nor Artery under it.

**MEDIASTINA**, is a Branch of the *Subclavial* Veins, which ordinarily comes from the Trunk of the *Cava*; it goes to the *Mediastinum* and *Thymus*.

**MEDIASTINUM**, is a doubling of the *Pleura*, or Membrane clothing the internal Parts of the *Thorax*, *Ribs*, &c. and it divides the Lungs and other *Viscera* of the Breast, into two Parts. It proceeds from the *Vertebres* of the Back, and going on forward, reaches the Breast-bone, and there makes an eminent Partition in the very middle of the *Thorax*.

**MEDIASTINUM cerebri** [in *Anatomy*] the same as *septum transversum*.

**MEDIATE** [*Mediatus*, L.] a Term of Relation to two Extremes apply'd to a third, which is in the middle; as to a second Cause, which is acted upon by some superior first Cause: the same as *intermediate*.

**MEDIATION**, according to some Writers of Arithmetick, is Division by 2, or taking the half of any Number or Quantity. This is called also *Bipartition*; and in reference to Lines, usually *Bisection*.

**MEDIATUS Linguae**, or *Party-fury*, is a Jury impanelled upon any Cause, wherein a Stranger is Party, whereof the one half consists of Denizens, the other of Strangers, and is used in Pleas, where one Party is a Denizen, and the other a Stranger.

**MEDICINE**, or as 'tis commonly called, *Physick*, is an Art assistant to Nature, and designed for the preserving of Health in Humane Bodies, as much as is possible, by the Use of convenient Remedies. *Sennertus* and others, divide it into five Parts.

1. *Physiologia*, which treats of an Human Constitution, as it is found and well; to which belongs *Anatomy* too.

2. *Pathologia*, which treats of the preternatural Constitution of our Bodies.

3. *Semiotica*, which treats of the Signs of Health and Diseases.

4. *Hygieina*, which delivers Rules for the *Regimen* to be observed in the Preservation of Health.

5. *Therapeutica*, which teaches the Management of Diet; and comprehends *Chirurgery*, and the Art of *Medicine*, properly so called.

The general Division of *Physick* is only into two Parts; the *Theory* and the *Practick*: An accurate Skill in both which, are necessary to make a Man a good Physician.

**MEDICINAL Hours** [with *Physicians*] are those proper to take Medicines in; of which there are 4 in the Day, viz. in the Morning fasting, about an Hour before Dinner, about 4 Hours after Dinner, and going to Bed.

**MEDIO Acquittando**, is a Writ Judicial, to distrain a Lord for the *acquitting* a *Mean* Lord from a Rent which he formerly acknowledged in Court, not to belong to him.

MEDITER-



MEDITERRANEAN [*Mediterraneus*, of *Medius* the Middle, and *Terra* the Earth] inclosed within the Land; as the Sea that flows within the Lands of *Europe* and *Africa* by the Streights of *Gibraltar*, and reaches into *Asia* as far as the *Euxine* Sea; and the *Palus Mæotis* is called the *Mediterranean Sea*.

MEDIUM [in *Logick*] as the *Medium of a Syllogism* is the mean or middle Term; it is an Argument, Reason, or Consideration, for which we affirm or deny any thing: or it may be said to be that Cause why the greater Extreme is attributed to, or deny'd of the less in the Conclusion.

MEDIUM, in *Natural Philosophy*, signifies that peculiar Constitution of any Space or Region through which Bodies move. Thus the *Æther* is supposed by some to be the *Medium* in which the Planets and heavenly Bodies move. The *Air* is the *Medium* in which all *Meteors* are generated and move; and by the means of which it is that all Land Animals, as Insects, Birds, Beasts, and Men, can breath and live. But Water is the *Medium* in which Fishes live and move. And whatever Density or Tenacity there is in the Parts of this *Fluid Medium*, whereby Bodies moving in it are hindered or stopped, so that the Motion becomes slower, or is made in part to cease, is called the *Resistance of the Medium*. And Sir *Isaac Newton* hath proved, That this Resistance of the *Medium* to the Motion of Bodies, is always as the Square of the Velocity of the moving Body. *Princip. Philos. Math.* p. 245. See *Resistance of the Medium*.

Arithmetical MEDIUM, is that which is equally distant from each Extreme, or which exceeds the lesser Extreme as much as it is exceeded by the greater, in respect of Quantity not of Proportion; thus 9 is a Medium between 6 and 12. This by Schoolmen is call'd *Medium rei*.

Geometrical MEDIUM, is that where the same Ratio is preserved between the first and second, and the second and third Terms; or that which exceeds in the same Ratio or Quota of itself as it is exceeded. Thus 6 is a *Geometrical Medium* between 4 and 9. This by Schoolmen is called *Medium Personæ*.

MEDIUS Venter. See *Thorax*.

MEDULLA Cerebri, is the white soft part of the Brain, cover'd on the outside with the Cortical Substance, which is of a more dark or ashy-colour. It is called also the *Corpus Callosum*, and is an Union or Conjunction of both sides of the Brain into one. *Willis* observed, That this Part consisted of an innumerable Number of *Striæ*, or *Fibræ*, tending length-wise: And *Malpighius* asserts, That by the help of a Microscope they appear so visible as to look something like the Teeth of an Ivory Comb.

MEDULLA oblongata, is that part of the Brain within the Skull, which is the beginning of the Spinal Marrow; it is about 3 or 4 Inches in length within the Skull, and then it descends to the *Os Sacrum*, thro' the Hole of the hinder part of the Head and the *Vertebræ*: It sends out ten pair of Nerves to the Chest, the Abdomen, and the Limbs. It is call'd also the *Common Sensory*, because the Original of the Nerves being there, it is the common Place or Receptacle of all that comes to the Brain by the external Senses.

MEDULLA Offium, Marrow in the Bones, is a soft fat Substance plac'd in the Cavities, or Porosities of the Bones; it is kept in a Membrane, and is quite destitute of all Sense; it is red in the greater Cavities, white in the less, and soft and succulent in spongy Bones.

MEDULLA Spinalis, or the Spinal Marrow, is the Continuation of the *Medulla Oblongata* without the Skull; and which passing through all the *Vertebræ* of the Back, ends at last at the *Os Sacrum*; it is a kind of Coagmentation of Nerves, sending out thirty pair of Nerves on each side to the Limbs, to the great Cavities, and other parts of the Body. If it be wash'd with a convenient Liquor, it will sever into a great many little Fibres, which also are very conspicuous in its Original, the *Medulla Oblongata*.

MEDULLA of a Plant, or rather Tree, is the same with *Cor*; which see.

MEDULLARY Oil, is the finer and more subtile part of the Marrow of the Bones; which passes into them not by Ducts (saith Dr. *Havers*) but by small Pores formed into the Vesicles or Glandules (which are conglomerated into distinct Lobules contained in several Membranes, or Bags; and these Bags are contained in one common Membrane investing the whole Marrow: And all these Vesicles, Bags, and Coat or Membrane, are propagated from the outward Coat of the Arteries) by which it passes from one to another, till it arrives at the Sides or extreme Parts of the Bone.

That part of it which is supplied to the Interstices of the Joints, passes into them by Passages, penetrating thro' the Bone into those Cavities, and formed for this end.

The Use of this Oil is either common to all the Bones, whose Temper it preserves and keeps them from being too brittle: Or more peculiar for the Joints; where it is very serviceable,

1. To lubricate the Extremities of the Bones, that they may move the more easily and freely.
2. To keep the Ends of the articulated Bones from too great an Incalcescence or Heat.
3. It preserves the Joints also from wearing by Attrition, or grating one against another. And
4. It preserves the Ligaments of the Joints from Driness and Rigidity; and lubricates those Parts of them also that slide upon the Bones, and it keeps the Cartilages which are join'd to any of the Bones in a flexible Condition.

MELA, is a Chirurgeon's Instrument, called also *Speculum*, the Vulgar call it *Tenta*, a Tent, from trying. It is made for the most part of Silver, or Ivory, and its Use is to probe Ulcers, or to draw a Stone out of the Yard, &c. It is of different Shapes, according as it is differently designed to be used.

MELANAGOGUES, are Medicines that expel black Choler, or Melancholy, as the Ancients us'd to express themselves.

MELANCHOLY, is a Doating, without a Fever or Raving; or a *Delirium* proceeding from a kind of Sadness of the Patient, whereby the Animal Spirits seem to be moved more slowly than they were wont. *Blanchard*.

MELICERIA, called also *Hydarthrus*, and *Ichor*, and sometimes *Hydrops Articularis*, is a Tumor shut up within a Tunick, proceeding from Matter like Honey, without Pain, round, yielding if pressed, but quickly returning again. It seems to proceed from the Lymphatick Particles which do not circulate right; and which, when the Moisture is evaporated, leave a honeyish kind of Substance. *Blanchard*.

MELICRATUM, is a Drink made one part of Honey, and eight parts of Rain Water.

MELIUS inquirendo, is a Writ that lieth for a second Inquiry of what Lands and Tenements a Man died seized, where Partiality was suspected upon the Writ of *Diem clausit extremum*.

MELOPES,



MELOPES, *Vibices*, *Enchymoma*, *Sugillationes*, all signify the same Thing; and are red Spots (like those which remain in the Skin after beating) in malignant and pestilential Fevers. *Blanchard*.

MELOS, a Disease of the Eye, when there is so great an Irruption of the *Uvea* Tunicle; that it seems like an Apple. *Blanchard*.

MEMBRANA, is a nervous, fibrous, broad, plain, white, and dilatable Substance, which covers the Bowels, the great Cavities of the Body, the Muscles, &c. and is endowed with an exquisite Sense.

MEMBRANA *Musculorum Communis*, the common Membrane, or covering of the Muscles, is spread over all the Body, except the Skull, and is knit by Fibres something loosely to the *Membrana Carnosa*, lying above it; and to the proper Membrane of each Muscle which lies under it; it is very thin, but strong, of a whitish Colour, and almost transparent. It serves not only as a common Bag to the Muscles, and helps to keep them in their proper Places; but also to moisten them, and to besmear their Tendons with a mucilaginous Liquor, which lubricates them, and forwards their Motion and Action.

MEMBRANA *Adiposa*. See *Adiposa Membrana*.

MEMBRANA *Carnosa*; the same that *Panniculus Carnosus*.

MEMBRANA *Nictitans*. See *Nictitans*.

MEMBRANA *Urinaria*; the same with *Allantois*.

MEMBRANOSUS, is a Muscle of the Leg, so called from the large membranous Expansion it is continuous with, inclosing all the Muscles of the *Tibia* and *Tarsus*; whence it is also called *Fascia lata*: It hath an acute fleshy Beginning from the Fore-part of the Spine of the *Os Ilium*, between the Origination of the *Sartorius* and Tendinous Beginning of the *Glutæus Magnus*; and being dilated to a fleshy Belly, which fills the Interstice made by the first of the two last-named Muscles and upper part of the *Rectus* and Fore-part of the *Glutæus Medius*, in its oblique Descent, becomes tendinous, four Fingers Breadth below the great *Trochanter*, whence it passes directly over the *Vastus Externus* to its proper Termination, at the superior Appendix of the *Fibula*; but in its Progress thither, it is conjoined with the tendinous Expansion of the *Glutæus Magnus*, which ariseth from the Spine of the *Ilium*, covering the external Part of the *Glutæus Medius*, and all the external Muscles of the *Tibia*, as well as those of the Thigh-bone; and descending over the *Patella*, comprehends the Muscles of the *Tarsus*, and joins with the *Ligamentum Annulare*, which retains the Tendons of the Toes and Feet: When this Muscle acteth, the Leg and Thigh are drawn outwards.

MEMBRED, in Heraldry, those Birds which are either whole-footed, or which have no Talons, are termed by this Word *Meimbred*.

MEMBRETTO, in Architecture, is the *Italian* Term for a *Pilaster* that bears up an Arch. These are often *fluted*, but not with above 7 or 9 Channels. They are frequently used to adorn Door-Cases, Gallery Fronts, and Chimney-Pieces, and to bear up the Corniches and Freezes in Wainscot.

MEMORY, is that Faculty of the Soul, which repeats Things perceived by former Sensations; or is the calling to mind of known and past Things; as when we conceive Heat or Light, Yellow or Sweet, &c. the Object being removed; and is as it were the Store-house of our *Idea's*.

MEMORY. Dr. Hook, in his *Op. Posthum.* p. 139, 140, &c. supposes *Memory* to be as much an Organ as the Eye, Ear, Nose, &c. and to have its Situation some where near the Place where the Nerves from the other Senses concur and meet; and he thinks, that the Memory being both improveable and impairable, appears from thence to be plainly organical; and that it is a kind of Repository of Ideas formed partly by our Senses, and chiefly by the Soul herself.

MENDOSA *Sutura*, or *Squammea*, is a scaly Connexion of the Bones of the Skull; as may be seen in the Bone of the Temples, and the Bone of the Fore-part of the Head.

MENINGES, (of *μενίγγη*, Gr.] are the thin Skins that inwrap the Brain, and which are called *Matres* by the *Arabians*; as if all the Membranes of the Body were propagated by and from them. They lie immediately within the Skull, and are two in Number, viz. the *Dura mater*, or *Crassa meninx*; and the *Pia mater*, or *Tenuis meninx*; which see.

MENINGOPHYLAX, [of *μενίγγη*, and *φύλαξ*, Gr. a Keeper] is that which preserves the Meninx or Membrane of the Head, as thin Gold or Silver Plates, which are applied when the Skull is opened. *Blanchard*.

MENINX; see *Mater dura* & *tenuis*.

MENISCUS *Glasses*, are those which are Convex on one side, and Concave on the other.

For finding the *Focus* of a *Meniscus*, the Rule is this:

*As the Difference of the Semi-diameters of the Convexity and Concavity, to the Semi-diameter of the Concavity; so is the Diameter of the Convexity to the Focal Length.*

MENOLOGY [*Μηνολόγιον*, of *μηνή*, a Month, and *λογος*, Gr. a Word.] A Calendar or monthly Register of Saints in the Greek Church.

MENOPEGIA, is a sharp Pain in the Head, affecting one single Place.

MENSALIA } were such Personages or Livings

MENSALS } as were united formerly to the Tables of Religious Houses; and therefore are by Canonists called *mensal Benefices*.

MENSES [in *Medicine*] the *Catamenia*, or monthly Courses or Evacuations of Women not with Child.

MENSTRUAL } [*Menstruus*, L.] an Epithet

MENSTRUOUS } apply'd to the Blood; which flows from Women in their common monthly Purgations.

MENSTRUUM, the Chymical Word for a dissolving Liquor. They gave it this Name, because some Chymists pretend that the compleat Dissolution of a Mixt Body cannot be done in less Time than 40 Days; which Period they call the *Philosophical Month*.

And from hence the Word *Menstruum* hath come to be the general Term for any Dissolvent; and any Liquor which will exactly dissolve all the Parts of any Body, is called a proper *Menstruum* for that Body: As *Aqua Regalis* is for Gold; *Aqua Fortis*, or Spirit of Nitre, for most other Metals, *Common Water* for Salt, or Sugar, &c.

And here it may not be amiss to give a Solution of one Difficulty, viz. Why great Lumps or Fragments of Gold, &c. will readily descend to the Bottom of the Glass; and yet when they come to be cut or divided into very small Particles or Atoms, tho' of the same specifick Gravity with those greater Lumps, yet these shall swim, and be suspended in the *Menstruum*.



In order to the accounting for which, we may first consider, That the Parts of no Fluid can be so easily separable, but that they will a little resist or retard the Descent of any heavy Body through them; and this Resistance is (*cæteris paribus*) still proportionable to the Surface of the descending Bodies. But the Surfaces of Bodies do by no means increase or decrease in the same Proportion as their Solidities do: For the Solidity increases as the Cube, but the Surface only as the Square of the Diameter. Wherefore 'tis plain very small Bodies will have much larger Surfaces, in Proportion to their solid Content, than larger Bodies will; and consequently, when they grow exceeding small, may easily be conceived to be buoyed up by the Fluid.

Indeed it doth sometimes happen that a *Menstruum* will dissolve and keep suspended in it, without letting them emerge to the Top, the Parts of a Body lighter in *Specie* than it; as when Camphire is dissolved into a Liquor, and that Liquor well mingled with Oil of Vitriol; which is an Effect not agreeable to the Laws of *Hydrostaticks*: But then it may be consider'd, that there may be some such peculiar Texture in the Parts of the Camphire, as may make them so join or adhere to the Parts of the Oil, as that, tho' heavier, yet they shall not be impelled up to the Surface, at least for a Time: Which we see is the Case, in some measure, of an accurate and well-proportioned Mixture of Oil and Water.

Mr. Boyle mentions a *Menstruum* which he extracted from Bread alone, that would work on Bodies more compact than many hard Minerals; nay, even on Glass itself, and do many Things that *Aqua Fortis* could not do. It was thus made: Cut Brown Household-Bread, either of Wheat or Rye, (though the Rye is best) into Slices; and when they are a little dried, fill with them a Glass Retort, and draw off in a Sand-Furnace by Degrees of Fire, what will come over. Separate the Oil from the Liquor in the Receiver by a Tunnel, or a Filtre, and in a gentle Heat free the Spirits from some of its Phlegm, (though this is not always necessary). With this, he saith, he drew Tinctures not only from Crude Corals, but even from the *Lapis Hæmatites*, and *Granates*, unpowder'd; nay, also from Diamonds and Rubies. Yet by no means was this so corrosive a Liquor as *Aqua Fortis*, or as the other acid Menstruums.

From hence therefore we may learn to suspend our Assent as to that bold Assertion of some Physicians and Naturalists, That 'tis impossible any Medicine can be found out, that shall dissolve the Stone in the Bladder or Kidneys, but what must also corrode and destroy the Vessels through which it passes in the Body. For there are many Menstruums effectually corrosive, that will not work at all on some Bodies; which yet other Things, though of no such corrosive Nature to the Tongue or the Touch, will readily dissolve. Thus Quicksilver will dissolve Gold, though there be no sensible Appearance of any Corrosiveness in the Mercury, either to the Finger, or even to the Tongue; and yet neither *Aqua Fortis*, nor Oil of Vitriol, nor Spirit of Nitre, will touch this Metal, though they are some of the most corrosive Menstruums in Nature. Cold Water will dissolve the White of an Egg; which the purest Spirit of Wine will not divide, but coagulate; as will also the acid Liquors, Spirit of Salt, and Oil of Vitriol. Thus also common Oil will dissolve Brimstone, though it appear so soft and smooth upon the Tongue, and will not

dissolve so much as an Egg-shell; and yet that general Dissolvent, *Aqua Fortis*, will not touch Brimstone. Many more Instances of this Nature might be given; by which it appears, that Menstruums do not operate by virtue of any manifest Quality, such as Heat, Moisture, or even Acidity itself, but rather by some mechanical and peculiar Fitness that there is between the Shape, Bulk, Solidity, &c. of the Corpuscles both of it and the Body to be dissolved.

*MENSTRUUM Peracutum*, is a Menstruum mentioned by Mr. Boyle, and made by drawing off Spirit of Nitre several times from Butter of Antimony. He saith, That by the Help of this, he was able, without a very violent Fire, and in a few Hours, to elevate a good Quantity of Crude Gold.

*MENSURABILITY*, is an Aptitude in a Body, whereby it may be apply'd or conform'd to a certain Measure.

*MENSURATION*, or *Measuring*, is to find the Superficial Area, or Solid Content, of all Surfaces and Bodies. The Rules to do which, as exactly as is possible, you will find under the Names of the several *Figures* and *Solids*.

*MEPHITICAL Exhalations*, are poisonous or noxious ones, issuing out of the Earth. These the *Latins* used to call *Mephites*; whence comes the *Italian Mofeta*, which is the Term they have for the famous *Grotta de Cani*, near *Puzzoli*, about two Miles from *Naples*, which is so called, because its poisonous Steams will kill Dogs, (and no doubt any other Animals) if held long over, and within the Stench of the Steams.

*MERCATOR's Chart*, or *Projection*, is a Projection of the Face of the Earth in *Plano*; wherein the Degrees upon the Meridian increase towards the Poles in the same Proportion that the parallel Circles decrease towards them.

'Tis called *Mercator's Chart*, or *Projection*, because *Mercator* was the first that published *Charts* so made: Tho' our Countryman Mr. *Wright* was really the first that made the Tables for this *Projection*.

Though the *Plain Chart* be very easy and useful in short Voyages, and will serve in the longest Voyages, if you sail home in or near the opposite Rhumb you went by; as the Ancients, who being Coasters, did before the Use of the Compass: Yet forasmuch as few Places, or indeed none but such as lie under the same Meridian, or under the Equinoctial, can therein be expressed according to their true Situation and Distance one from another; but if they be laid down true by the Course and Distance, the Difference of Longitude will be false; if they be laid down by the Course and Difference of Longitude, then will the Distance and Difference be more than it should be; and if they be laid down by their Distance and Difference of Longitude, (which in many Cases is impossible) then the Difference of Latitude will always be too little, and the Rhumb too wide for the Meridian; and if they be laid down by their Latitudes and Separation, then the Course will be wide, and the Distance too much, &c.

And since that the Places in particular *Maps* or *Charts* being laid down in some one way, and in others another, and these Pieces many times tack'd together, without due Consideration of the differing Methods Places have been laid down by: This, I say, being so, the *Geography* and *Hydrography* of the World is so corrupted, that too many Descriptions of the whole, or of the large Parts of it, are



enormously erroneous, and the Shape of the Land much distorted. It were to be wished therefore, that the World would not put over-much Value on, but wean itself from the Use of the *Plain Chart*; and by making the *true Chart* easy and familiar, bring it into Respect and Use.

It was the great Study of our Predecessors, to contrive such a *Chart in Plano*, with strait Lines, on which all or any Parts of the World might be truly set down according to their Longitudes, Latitudes, Bearings or Distances.

A Way was hinted for this near Two thousand Years since by *Ptolemy*, and a general Map according thereto, made in the preceding Age by one *Mercator*; but the Thing demonstrated, and a ready Way shew'd of describing it, was not 'till Mr. WRIGHT taught to enlarge the *Meridian Line* by the continual Addition of Secants; so that all the Degrees of Longitude might be proportional to those of Latitude, as on the Globe. Which he has done after such an excellent Manner, that in many Respects it is far more convenient for the Navigator's Use, than the Globe itself; and will truly shew the Course and Distance from Place to Place, which way soever a Ship sails forth, or return.

### PROBLEMS.

1. To find the Meridional Miles answering to any Difference of Latitude.

First, By the *Table of Meridional Parts*, which are printed in most Books of Navigation,

Find the Degrees of either Latitude over-head, and the Minutes in the Left-hand Column downwards; and in the Angle of meeting are the Parts for that Latitude.

Thus also find out the Parts for the other; then, if both Latitudes be of the *same Name*, that is, both North, or both South, subtract these one from the other; and that Remainder contains the *Meridional Miles* sought. If of *different Name*, add them together; as in *Example 2*.

#### Example.

Required to find the *Meridional Miles* between Latitude  $43^{\circ} 15'$  North, and  $50^{\circ} 20'$  N.

$$\begin{array}{r} \text{Latitude } 50^{\circ} 20' \text{ — — — } 35057 \\ \text{Latitude } 43 \quad 15 \text{ — — — } 28837 \end{array} \left. \vphantom{\begin{array}{r} 35057 \\ 28837 \end{array}} \right\} \text{Mer. Pt.}$$

Merid. Difference of Lat. — 6220.

#### Example 2.

$$\begin{array}{r} \text{Let one Lat. be } 20^{\circ} 19' \text{ S. — } 12423 \\ \text{The other Lat. } 18 \quad 53 \text{ N. — } 11541 \end{array} \left. \vphantom{\begin{array}{r} 12423 \\ 11541 \end{array}} \right\} \text{Mer. Pt.}$$

Merid. Difference of Lat. — 23963 Sum.

### PROBLEM II.

2. To find the Meridional Difference of Latitude by the *Table of Artificial Tangents*.

The *Logarithmick Tangents* above 45 Degrees, accounting every 30 Minutes to be one Degree, and every Minute to be two Minutes of the *Meridian Line*, are in the same *Ratio* with the *Meridional Parts*, made by the continual Addition of *Natural Secants*.

Therefore, Take half of each of the given Latitudes, and to each Half add  $45^{\circ}$ , looking the *Tangents* of their *Arches* in the *Table of Logarithmick Tangents*; the Difference of these *Tangents* divide by 1263, the Quotient will be the *Meridional Miles* or *Minutes*.

#### Example 1.

$$\begin{array}{l} \text{Lat. } 50^{\circ} 20', \text{ its } \frac{1}{2} = 25^{\circ} 10'; \text{ which} \\ \text{added to } 45^{\circ}, \text{ makes } 70^{\circ} 10', \text{ whose} \\ \text{Tangent is — — — — —} \end{array} \left. \vphantom{\begin{array}{l} 25^{\circ} 10' \\ 70^{\circ} 10' \end{array}} \right\} 4428786$$

$$\begin{array}{l} \frac{1}{2} \text{ Lat. } 43^{\circ} 14', \text{ is } 21^{\circ} 37' \frac{1}{2}; \text{ which} \\ \text{added to } 45^{\circ}, \text{ makes } 66^{\circ} 37' \frac{1}{2}, \text{ whose} \\ \text{Tangent is, omitting the Index, — — — — —} \end{array} \left. \vphantom{\begin{array}{l} 21^{\circ} 37' \frac{1}{2} \\ 66^{\circ} 37' \frac{1}{2} \end{array}} \right\} 3642940$$

785846

$$1263) 785846 \quad (622 = \text{Merid. Diff.}$$

280

278 —

260

#### Example 2.

$$\begin{array}{l} \text{The } \frac{1}{2} \text{ of Lat. } 20^{\circ} 17' \text{ S. is } 10^{\circ} 18' \frac{1}{2}; \\ \text{which added to } 45^{\circ}, \text{ make } 55^{\circ} 8' \frac{1}{2}; \\ \text{whose Tangent is — — — — —} \end{array} \left. \vphantom{\begin{array}{l} 10^{\circ} 18' \frac{1}{2} \\ 55^{\circ} 8' \frac{1}{2} \end{array}} \right\} 1570607$$

$$\begin{array}{l} \frac{1}{2} \text{ Lat. } 18^{\circ} 53', \text{ N. is } 9^{\circ} 26' \frac{1}{2}; \\ \text{which added to } 45^{\circ}, \text{ makes } 54^{\circ} \\ 26' \frac{1}{2}, \text{ its Tangent is — — — — —} \end{array} \left. \vphantom{\begin{array}{l} 9^{\circ} 26' \frac{1}{2} \\ 54^{\circ} \end{array}} \right\} 3028577 \text{ Sum.}$$

$$1263) 3028577 \quad (2397 = \text{Mer. Diff. Lat.}$$

50260

123

100

1166

### PROBLEM III.

3. The Latitudes and Difference of Longitudes of two Places given, to find the Course and Distance between them.

Admit the *Course* and *Distance* between the *Lizard*, in Latitude  $50^{\circ} 10'$  N. and *Antego* in Latitude  $17^{\circ} 25'$  N. whose Difference of Longitude is  $54^{\circ} 15'$  W. be required.

$$\begin{array}{l} \text{From } 50^{\circ} 10' \left. \vphantom{50^{\circ} 10'} \right\} \text{N. Lat. } \left\{ \begin{array}{l} \text{Lizard} \\ \text{Antego} \end{array} \right\} \text{M. Pt. } \left\{ \begin{array}{l} 3490 \\ 1061 \end{array} \right. \\ \text{Subtr. } 17 \quad 25 \end{array}$$

32 45

60

2429 = to

(Merid. Diff. Lat.

1965 = Diff. Lat.

Diff. Long. =  $54^{\circ} 15'$

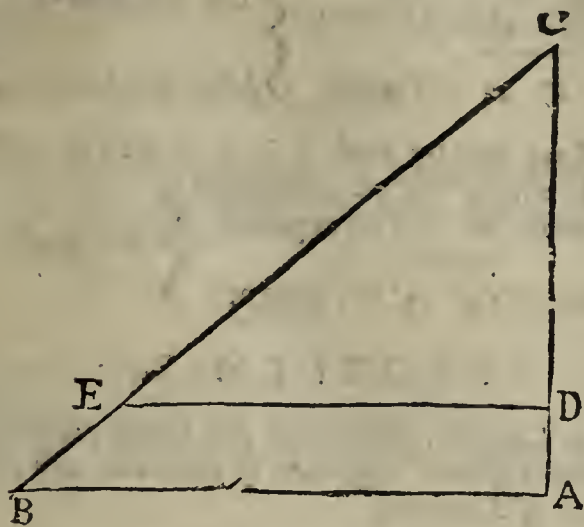
(= 3255 Miles W.

#### Geometrically.

Draw the *Meridian* CA, which make equal to 2429, the *Merid. Diff. Lat.* Erect the *Perpendicular* AB, which let be equal to the *Difference of Longitude* 3255; draw CB; make CD equal to the proper *Difference of Latitude* 1965; and erect the *Perpendicular* DE.

In





In the Triangle ABC } Given {  $CA = \text{Mer. Diff. Lat.} = 2429$   
 } Requi- {  $BA = \text{Differ. Longit.} = 3255$   
 } red. {  $\angle C = \text{Course.}$   
 } {  $\angle B = \text{Compl. Course.}$

In the Triangle CDE } Given {  $CD = \text{Proper Diff. Lat.} = 1965$   
 } and  $\angle C = \text{Course.}$   
 } Requi- {  $CE = \text{Dist. of the Places.}$   
 } red. {

For the *Course*, say,

As Mer. Diff. Lat. : Rad. :: Diff. Long. : T. Course  
 $2429 \text{ min.} : T. 55^\circ :: 3255 \text{ min.} : T. 53^\circ 16'$

Operation by the Logarithms.

To the Arithmetical Com- }  
 plement of the Log. Mer. }  $2429 - 6.614573$   
 Diff. Lat. — — — }  
 Add the Log. of the Diff. Long.  $3255 - 3.512551$   
 Sum is the T. of the Course,  $53^\circ 16' - 10.127124$

By Gunter's Scale.

The Extent from —  $2429$  } on the Line of  
 to — — — — —  $3255$  } Numbers.  
 Will reach from T.  $45^\circ 00'$  }  
 to the T. of the }  $53^\circ 16'$  } on the Line of  
 Course — — — } Tangents.

For the *Distance*, say,

As the Co-Sine of the Course : Rad. :: D. L. :  
 Dist. S.  $36^\circ 44' : S. 90^\circ 00' :: 1965 : 3285$

Operation by the Logarithms.

To the Arithmetical Com- }  
 plement of the Co. S. }  $36^\circ 44' - 0.22323$   
 Course — — — — — }  
 Add the Log. of the Diff. Lat.  $1965 - 3.29336$   
 Sum is the Log. of the Distance  $3285 - 3.51659$

By Gunter's Scale.

The Extent from S.  $36^\circ 44'$  } on the Line of  
 to the — — — — — S.  $90^\circ 00'$  } Sines.  
 Reaches from — S.  $1965$  — } on the Line of  
 to — — — — —  $1965$  — } Numbers.

#### PROBLEM IV.

4. The Latitude and Course given, the Distance, Difference of Longitude, and Departure, required.

Example.

Sailing from the *Lizard*, Lat.  $50^\circ 10' N.$  and the Course being  $53^\circ 16' S.$  Westerly. (Variation and Leeward-way, &c. allow'd for) or S. W.  $\frac{3}{4}$  W. near; and finding by Observation the Ship to be in Latitude  $17^\circ 25' North$ ; What's the *Distance run*, *Departure*, and *Difference of Longitude*?

From  $50^\circ 10' N.$  } Lat. { *Lizard* } M. Pt. {  $3490$   
 Subst.  $17^\circ 25' N.$  } { *observ'd* } {  $1061$   
 Rem.  $32^\circ 45' = 1965 = \text{Diff. Lat. M.}$  Diff. Lat.  $2429$

*Distance*, What?

As the Sine of the Course : Rad. :: Diff. Lat. : Dist.  
 and  $36^\circ 44' : S. 90^\circ 00' :: 1965 : 3285$ .

*Departure*, What?

Radius : Mer. Diff. Lat. :: T. Course : Diff. Long.  
 $T. 45 : 2429 \text{ min.} :: T. 53^\circ 16' : 3255 \text{ min.}$

Operation by the Logarithms.

To the Log. Mer. Diff. Lat.  $2429 - 3.38542$   
 Add the Tangent of the Course,  $53^\circ 16' - 10.12712$   
 Sum = Log. Diff. Longitude,  $3255 - 3.51254$

By Gunter's Scale.

The Extent from T.  $45^\circ$  } on the Line of  
 to the Tangent of  $53^\circ 16'$  } Tangents.  
 Reaches from —  $2429$  } on the Line of  
 to — — — — —  $3255$  } Numbers.

#### PROBLEM V.

5. The Latitude and Distance being given, Course, Departure, and Difference of Longitude are required?

Example.

Sailing North-Eastward from *Antego*  $3285 \text{ min.}$  and by Observation finding my Latitude to be  $50^\circ 10' North$ ; What's the *Course*, *Departure* and *Difference of Longitude*.

From  $50^\circ 10' N.$  } Lat. { *observ.* } M. Pt. {  $3490$   
 Subst.  $17^\circ 25' N.$  } { *Antego* } {  $1061$   
 Rem.  $32^\circ 45' = 1965 = \text{Diff. Lat. M.}$  Diff. Lat.  $2429$

*Course*, What?

Distance : Diff. Lat. :: Radius : Co-sine Course,  
 $3285 : 1965 :: S. 90^\circ 00' : S. 36^\circ 44'$

Operation by Logarithms.

To the Arithmetical Com- }  
 plement of the Log. of }  $3285 - 6.48341$   
 the Distance — — — }  
 Add the Log. of the Diff. Lat.  $1965 - 3.29336$   
 Sum = Co-sine of the Course,  $36^\circ 44' - 9.77677$

By



By Gunter's Scale.

The Extent from Distance 3285 } on Line of  
to the Diff. Lat. — 1965 } Numbers.  
Reaches from S. of Radius, 90° 00' } on Line of  
to the S. Compl. of Course 36 44 } Sines.

Then the { Departure } is found by Prob. I. II.  
Diff. Longit.

### PROBLEM VI.

6. The Latitude and Departure given, Required the Course, Distance, and Difference of Longitude.

Example.

A Ship from Latitude 50° 10' N. and Longitude 00° 00' runs South-westerly 'till her Departure be 2633 Miles, and the observed Latitude 17° 25' North, I demand the Course, Distance, and Difference of Longitude?

Diff. Lat. : Departure :: Radius : T. Course. 1965  
: 2633 :: T. 45° 00' : T. 53° 16'.

Operation of the Logarithms.

To Ar. Co. Log. of Diff. Lat. 1965 — 6.70664  
Add the Log. of Departure 2633 — 3.42048

Sum = T. of the Course — 53° 16' — 10.12712

By Gunter's Scale.

The Extent from Diff. Lat. 1965 } on Line of  
to the Departure — 2633 } Numbers.  
Reaches from T. of Radius, 45° 00' } on Line of  
to the T. of the Course 53 16 } Tangents.

Then { Distance } is found by Prob. I. II.  
Differ. Longit.

### PROBLEM VII.

7. One Latitude, Course and Distance given; the Difference of Latitude, and Difference of Longitude required.

Example.

A Ship from 50° 10' N. Latitude, and 00° 00' Longitude, runs with a Course 16° 32' S. westerly 3285 Miles: What is the Difference of Latitude, and Difference of Longitude?

For the Difference of Latitude, say,

Radius : Co-Sine Course :: Distance : Differ. Lat.  
S. 90° 00' : S. 36° 44' :: 3284 m. : 1965.

Operation by the Logarithms.

To the 7 of the Course 53° 16' — 9.77676  
Add the Logar. Distance 32 85 — 3.51659

Run = Log. Diff. Lat. — 19 65 — 3.29335

By Gunter's Scale.

The Extent from S. Radius, 90° 00' } on Line of  
To the S. Compl. Course 36 44 } Sines.  
Reaches from the Distance 32 85 } on Line of  
To the Differen. Latitude 19 65 } Numbers.

From 50° 10' = departed } Lat. Mer. Pts. { 3490  
Subst. 32 45 = Differen. } 1061

Rem. 17 25 = Present } Mer. Diff. Lat. = 2429

Diff. Long. find by Prob. 2. in 3255 = 54° 15' W.  
From 54° 15' = Difference } Longitude.  
Subst. 00 00 = departed

Rem. = 54° 15' W. Present

### PROBLEM VIII.

8. One Latitude, Departure and Course given: Required Distance, Difference of Latitude, and Difference of Longitude.

Example.

Sailing South 53° 16' West, from Latitude 50° 10' North, Longitude 00° 00', till my Departure be 2633 Miles: What's my Distance, Latitude, and Longitude?

Distance } by C. 6. of Plain Sail. is { 3285  
Diff. Lat. } 1965 = 3245

From 50° 10' N. = departed } L.M.P. { 3490  
Subst. 32 45 N. = Difference } 1061

Rem. = 17 25 = 1985 X Pref. } M.D. Lat. 2429

For the Difference of Longitudes, say,

Proper Diff. Lat. : M. R. Diff. Lat. :: Depart. : D.  
Long. 1965 m. : 2429 m. :: 2633 : 3255.

Operation by Logarithms.

To Ar. co. Log. Diff. Lat. 1965 — 6.70663  
Add the Log. { Mer. Diff. Lat. 2429 — 3.38542  
{ Departure 2632 — 3.42049

Sum = Log. Diff. Long. 3255 = 54° 15' 3.51254

By Gunter's Scale.

The Extent from Diff. Lat. 1965 }  
To the Mer. Differ. Latit. 2429 } on Line of Num.  
Reaches from Departure 2633 }  
To the Differ. of Long. 3255 }

From 00° 00' = departed } Longitude.  
Subtract 54 15 = Difference }

Rem. = 54 15 W. = Present.

### PROBLEM IX.

9. One Latitude, Distance, and Departure given: The Course, Difference of Latitude, and Difference of Longitude required.

Example.

From Latitude 50° 10' N. and Longitude 00° 00', sailing South Westward 3285 m. until the Departure be 2633 m.: I demand the Course sail'd, Latitude and Longitude.

By C. 4. of Plain Sailing { Course = 53° 16' W.  
{ Diff. Lat. = 1965

By Prob. 6. Present Latitude = 17° 45' N.  
And Meridian Differ. Latitude = 2429  
Difference



Difference } Long. by Prob. 6. is } 3255 = 54° 15'  
Present } ——— 54 16

PROBLEM X.

10. One Latitude, Course and Difference of Longitude given: The Difference, Latitude, Distance, and Departure required.

Example.

From Latitude 53° 10' N. sailing South 53° 16' Westerly, 'till I am in the Longitude 54° 45' W. What's my Distance, Departure and Difference of Latitude?

From 00° 00' N. Departed }  
Subtract 54 15 W. Present } Longitude.  
Rem. = 54 15 = 3255 = Differ.

For the Meridian Difference of Latitude, say,

Radius : c T. Course :: Diff. Long. : Mer. Diff. Lat.  
T. 45° : T. 36° 44' :: 3255 : 2429 m.

Operation by the Logarithms:

To the c T. Course ——— 36° 44' ——— 9.87290  
Add Log. Diff. Longit. 3255 m. ——— 3.51255  
Sum Rad. = Log. Mer. Diff. Lat. 2529 m. 3.38545

By Gunter's Scale.

The Extent from T. Radius 45° } on Line of  
To T. Compl. Course 36° 44' } Tangens.  
Reaches from Diff. Long. 3255 } on Line of  
To Merid. Differ. Latit. 2429 } Numbers.

From 3490 }  
Subst. 2429 } Mer. { Parts in Dep } 50° 10'  
Rem. 1061 } { Difference } Lat. { North.  
                  { Parts in pref. } 17 25

Then find the Distance and Departure, by Case 2. Plain Sailing.

PROBLEM XI.

11. The Difference, Longitude and Distance of two Places in the same Latitude being given, to find the Latitude.

Example.

Two Ships in the Equator 400 Miles from one another; one sails North, the other South alike Distances, till they are 150 Miles asunder: What Latitude are they in?

Proportion.

Differ. Long. : Radius :: Distance : S. Latit.  
400 : S. 90° 00' :: 150 M. : S. 22° 01'

Operation by the Logarithms.

To the Ar. co. Log. Diff. Long. 400 ——— 7.39794  
Add Logarithm of the Distance 150 ——— 2.17600  
Sum = S. Latitude ——— 67° 59' ——— 9.57394

By Gunter's Scale.

The Extent from Differ. Long. 400 } on Line of  
To the Distance — — — 150 } Numbers.

Reaches from S. Radius 90° 00' } on Line of  
To S. Compleat Latitude 67 59 } Sines.

PROBLEM XII.

12. The Differences of Longitude between two Places of the same Latitude, being given: To find their Distance.

Example.

The Distance between Martinico and Cape Verde is required.

From 54° 50' } = Long. { Martin. } L. 14° 50'  
Subst. 11 30 } { C. Verde. } North.

Rem. = 43 20 = 2600 Miles = Differ. Long.

Radius : Diff. Long. :: S. Latit. : Distance.

Operation by Logarithms.

To Log. Differ. Longitude 2600 ——— 3.41497  
Add the S. Latitude 14° 50' ——— 9.91528  
Sum — Rad. = Log. Distance 2513 ——— 2.40025

By Gunter's Scale.

The Extent from S. Rad. 90° 00' } on Line of  
To the S. Com. Latitude 75 10 } Sines.  
Reaches from Differ. Longit. 2600 } on Line of  
To the Distance — — 2513 } Numbers.

PROBLEM XIII.

13. The Distance between two Places in the same Parallel given: Required, To find the Difference of Longitude.

Example.

Sailing from Cape Verde, in Latitude 14° 50' North to an Island 2513 Miles West: I demand the Longitude of the Island.

c S. Lat. : Distance :: Radius : Diff. Long.  
S. 75° 10' : 2513 :: S. 90° 00' : 2600 Miles.

Operation by the Logarithms.

To ar. co. S. Latitude 14° 50' ——— 9.01472  
Add Log. of the Distance 2513 ——— 3.40025  
Sum = Log. Dist. Long. 2600 Miles ——— 3.41797

By Gunter's Scale.

The Ext. from S. Compl. Lat. 75° 10' } on Line of  
To the Sine of the Radius — 90 00 } Sines.  
Reaches from Distance — 2513 } on Line of  
To the Differ. of Longitude - 2600 } Numbers.

To 2600 | = 43° 20' = Diff. Long. in D. and M.  
Add 60 | 11 30 = Long. of Cape Verde.

Sum = 54 50 = Longitude of the Place the Ship is in.

That the Meridian Line in Mercator's Chart, is a Scale of Logarithmick Tangents of the half Complements of the Latitude: The incomparable Mr. Halley demonstrates thus:



## P R O B L E M.

*To find the Sun's Meridian Altitude or Depression at Night by the Globes.*

Bring the Sun's Place to the *Meridian* above the Horizon, for his *Noon-Altitude*; which will shew the Degrees of it, counted from the Horizon. For his *Midnight-Depression* below the North Point of the Horizon, you must bring the opposite Point to the Sun's present Place, as before to the *Meridian*; and the Degrees there intercepted between that Point and the Horizon, are his *Midnight-Depression*.

*MERIDIAN Line*, on a Dial, is a Right-Line arising from the Intersection of the Meridian of the Place with the Plane of the Dial. This is the Line of 12-a-clock, and from hence the Division of the Hour Lines begins.

*To draw a true Meridian Line upon an Horizontal Plane.*

First, Get a plain thick Board, of a Foot square or more; then upon one of the Edges or Corners, as near as may be, fasten a strong Iron Pin, about 10 or 11 Inches long, and make it so fast, that it will not shake or yield in the least: It matters not whether it be perpendicular or not.

Set this Board horizontally in your Garden with Earth or Sand upon the Ground, or elsewhere about 9-a-clock; (the best Time is, when the Sun is near the Solstice, suppose about the 10th of *June*) see where the Head of this Iron Pin (which must be sharp at the top) giveth its Shadow upon the Board, mark that Place: Then take a Wooden Ruler, sharp also at one end, and lay it so upon the sharp end of the Iron Pin, that the sharp end of the Ruler may touch the Mark; then carrying it steady, make the Segment of a Circle towards the North. Come again about 3-a-clock in the Afternoon, and mark where the Shadow of the top of the Iron Pin is, in that Segment again. Then draw a Line from those two Marks, which will be East and West, and the Perpendicular to that Line will be a *Meridian*; and if you halve that Line, the Perpendicular will go through the Centre of the whole Circle: For that Segment is part of the Basis of a Cone, whose Vertex is the top of the Iron Pin.

But because the Sun may be under a Cloud, when you come at 3 a-clock, you may make three or four more Segments, and use them as you used this.

This Method would be very exact, if the Sun moved as the Fix'd-Stars do; but because the Sun hath a proper Motion, as a Planet, there will be some inconsiderable Error, which yet may be corrected; for seeing the Sun in one Minute of an Hour moveth as much by his daily Motion, as he loseth in 6 Hours by his proper Motion; you shall add as much in the way which the Shadow goes in the last Mark, as that Shadow moveth in one Minute, which you may measure by your Pulse or Pendulum; so the last Point will not be taken just in the Segment, but a little without it.

Under the Word *Pole-Star*, you have another good Method for drawing a true *Meridian Line*.

Mr. Stephen Gray, in *Philosophical Transactions*, N<sup>o</sup> 260, gives a new Method of drawing a true *Meridian Line* by the *Pole-Star*; as also, *How to find the Hour by the same*. Thus,

Take the Gnomon of an horizontal Dial for the Latitude of the Place, and to the Hypothenuse fix

two Sights, whose Centres may be parallel to the same: Let the Eye-sight be a small Hole; but the other's Diameter must be equal to the Tangent of the double Distance of the North-Star from the Pole, the Distance of the Sights being made *Radius*. Let the Stile be riveted to the End of a straight Ruler; then when you would make use of it, lay the Ruler on an horizontal Plane, so that the End to which the Ruler is fix'd, may hang over: Then look through the Eye-sight, moving the Instrument till you see the North-Star appear to touch the Circumference of the Hole in the other Sight, on the same Hand with the Girdle of *Cassiopeia*; or on the opposite side to that, whereon the Star in the Great Bear's Rump is at that Time: Then draw a Line by the Edge of the Ruler, and 'twill be a true *Meridian Line*, as is very easy to demonstrate.

In *Philos. Transf.* N<sup>o</sup> 270, he improves this Method, and describes an Instrument, whereby he not only draws a true *Meridian*, but finds the Hour and Minute of the Day or Night, by the Help of the Pole-Star, exactly. His Instrument he thus describes:

Let there be taken a Telescope, of about 16 Foot, or longer, if you please; in the Plane of its *Focus*, place a Ring of Brass at Right Angles to the Glass, the Diameter of the inward Circle being equal to the double Tangent of the Pole-Star's Distance from the Pole; the Focal Length of the Object-Glass being made *Radius*, as was said in the Description of the *Meridian Instrument*. Let the Ring be divided into 24 Hours, with their Minutes numbred from the Right Hand towards the Left, as in our common Nocturnals: The Eye-Glass must be equal in its Diameter to the Horary Ring. But this perhaps will be thought too chargeable, especially for such large Telescopes as he speaks of; wherefore he gives this Contrivance: The Eye-Glass must lie in a broad Index, towards one End; this is to turn on a Centre-pin that lies in the Centre of the Glass, and consequently over the Centre of the Horary Ring, from which it must be equal to the Distance of the Focus of the Eye-Glass; then let the Tube be elevated to the Height of the Pole, and directed to the Pole-Star, till by turning the Index about, you can perceive the Star to touch the Horary Ring on that side the Star in which the Great Bear's Rump lies, or on the opposite to that in the Hip of *Cassiopeia*: But on the contrary, had not the Glass inverted the Object, then bring one of the Twelves to be in a Perpendicular to the other, by a plain Line; so will the Star stand at its Horary Distance from the *Meridian*: Or if the Latitude of the Place be unknown, by the Right Ascension of the Sun and Star, the Time of its coming to the *Meridian* will be easily obtain'd, then the Hour of the Night found, will as easily give the Star's Horary Distance from the *Meridian*. Then elevate the Tube towards the Star, bringing the *Meridian*, or 12 and 12, into the Plane of the Perpendicular; turn the Glass about, till you see the Pole-Star stand at its Horary Distance from the *Meridian*; so will the Instrument, when fix'd, shew the Horary Distance throughout the whole Day, or as long as it remains in this Position, by the apparent Motion of the Star in the Ring.

The best Time to fix the Instrument, will be when this, or any of the other two Stars above-mention'd, are above 6 Hours from the *Meridian*.

Note, That the Latitude of the Place is now given with the utmost Preciseness; for the Axis of the Glass lies now in the Axis of the World; and it



one of the Sides of the Tubes be parallel thereto, as it ought to be, at the upper End hang a Line or Plummert, from the Point of Suspension; find another Point equal in Distance to the Length of the Line, or a Knot towards the lower End, the Distance from this Knot to the former Point will be but the Chord of the Latitude; and if from the same Edge of the Index another Line and Plummert be hung towards the lower End of the Tube, these two Lines, when at rest, will be in the Plane of the *Meridian*.

This Instrument may be made to shew the Hour with as much Facility as a Clock or Sun-Dial, if the Horary Ring be made to move within a larger fixed one; and the outward Circle of the former be divided into the Days of the Month, respect being had to the Right Ascension of the Sun and Star: Then bringing the two opposite Points in the fixed Circle, to the Perpendicular, which is done at the fixing of the Instrument, move the Circle 'till the Day of the Month come to any of these, and the Ring is rectified for that Day; and if the Air be clear, you'll see the Star stand at the true Time of the Day or Night.

It may be objected, That in few Years, by the annual Increase of its Declination, the Pole-Star will, by moving in a lesser Circle, be brought too far from the Edge of the Ring, that the exact Hour and Minute cannot well be distinguished. But this Inconveniency, when it is one, may be remedied several ways; either by making a lesser Ring, or by extending a fine Thread of Silk cross the Ring, 'till it cuts the Star, and at the same time it gives the Hour; or, which will yet make this Instrument commodious for other Purposes, there may be made an Index to move on the Centre of the Hour-wheel, which being brought to cut the Star with the Edge that proceeds from the Centre, it will at the same time cut the Hour. And you need not be solicitous about the exact Diameter of the Ring, provided it do but a little exceed the Distance of the Pole-Star from the Pole, the focal Length of the Glass being made Radius.

Our most accurate and judicious Astronomer, Mr. *John Flamsteed*, has discovered, That there is a Parallax of the Earth's annual Orbit at the Pole-Star, of about 40 or 45 Seconds; whereby the Diameter of the Star's Parallel is greater in *June* than in *December*, by about one Minute two Seconds; which he has evinced from seven Years successive Observations: Whereby the Earth's annual Motion is indubitably demonstrated, as appears from his learned Letter to Dr. *Wallis* on that Subject.

Now if on the Edge of this Index there be drawn a Scale of Degrees, Minutes and Seconds, to the Radius of the Glass, we shall not only have a very accurate Instrument for the Hour, but be furnish'd with one whereby we shall see the Truth of the Earth's Motion confirmed by the Access and Recess of our Star towards and from the Pole, according to the Earth's Place in the Ecliptick, as that learned Person above-mentioned has discover'd; and that not only when the Star transits the *Meridian*, but in a clear Air at any time of the Day: One shall likewise observe that annual Increase of the Pole-Star's Declination, caused by the Procession of the Equinox.

Moreover, he, from his own Observation, assures us, That the Pole-Star may be seen in the Day-time with a Telescope of 16 Foot; of which he gives particular Instances: As, on the 26th of *April*, 1701, with such a Telescope he saw the Pole-Star from four a-Clock in the Morning 'till

seven, and could have seen it longer, had not Clouds interpos'd. Also, on the 1st of *May*, he did not look for the Star 'till the Sun had been up more than half an Hour, viz. at Five in the Morning, yet soon found it; and saw it afterwards at pleasure, 'till half an Hour after Nine the same Morning. So that 'tis not to be doubted, but this Star may be seen in a clear Day throughout the Year.

The Declination of the Pole-Star for the Year 1700, is  $87^{\circ} 42' 51''$  by *Ricciolus* his Catalogue of Fixed-Stars, in the *Appendix* to Mr. *Edward Sherbourn's Sphere of Manilius*, &c. Hence its Distance from the Pole at that Time might be assumed  $2^{\circ} 17'$  the Focal Length of the Object-glass being 15 Foot 6 Inches; so that the Diameter should be 14 Inches and  $\frac{3}{4}$  Parts of an Inch, which is the natural Tangent of the former Ark  $2^{\circ} 17'$  doubled; a Circle large enough to be divided into Minutes and Halves, which will be so magnified by the Eye-Glass, that 'twill be easy to distinguish the Time to a few Seconds.

'Tis true, there is some Difficulty in fixing up this Instrument; and when it is so, to keep it from varying from its due Position; but yet 'tis not insuperable. And for small Instruments, of about 2 or 3 Foot long, there cannot be a more accurate, facile, and expeditious Way than this for drawing a *Meridian Line*.

Now whether the many Benefits that may accrue to Astronomy, do not make the larger one worthy of the Charge and Trouble that may be in completing it, he leaves to the Consideration of the Learned.

**MERIDIAN Line**, is a Line of ready Use in Practical Navigation. 'Tis always placed on the Foot, or 2 Foot *Gunter's Scales*, and sometimes on the Side of *Gunter's Sector*, (and on the Cross-Staff, &c.) and continued to its whole Length. 'Tis divided unequally towards  $87$  Degr. (whereof  $70$  Gr. are about one half) in such manner as the Meridian in *Mercator's Chart* is divided and numbered.

Its Uses are many: For, 1. It serves them to graduate a Sea Chart according to the true Projection. 2. Being joined with a Line of Chords, it serves for the Protraction and Resolution of such Right-lined Triangles as are concerned in Latitude, Longitude, Rhumb, and Distance in the Practice of Sailing; as Mr. *Gunter* shews, p. 15. of his Book of the Cross-Staff; as also in pricking the Chart truly at Sea.

**MERIDIAN Magnetical**, is a great Circle passing through or by the magnetical Poles; to which Meridians, the Compass (if not otherwise hindered) hath respect.

**MERIDIONAL Distance**, in Navigation, is the same with the Departure, Easting or Westing, or the Difference of Longitude between the Meridian under which the Ship now is, and any other Meridian she was before under.

**MERIDIONAL Parts**, Miles, or Minutes, in Navigation, are the Parts by which the Meridians in Mr. *Wright's Chart* (commonly, though falsely, called *Mercator's*) do increase as the Parallels of Latitude decrease: And the Co-sine of the Latitude of any Place being equal to the Radius or Semi-diameter of that Parallel, therefore in the true Sea Chart, or Nautical Planisphere, this Radius being the Radius of the Equinoctial, or whole Sine of  $90^{\circ}$ ; the Meridional Parts at each Degree of Latitude must increase, as the Secants of the Ark contained between that Latitude and the Equinoctial do decrease. The Tables therefore of *Meridional*



*ridional Parts*, which you have in Books of Navigation, are made by a continual Addition of Secants: They are calculated in some Books (as in Sir *Jonas Moore's Tables*) for every Degree and Minute of Latitude; and these will serve either to make or graduate a *Mercator's Chart*, or to work the *Mercator's Sailing*. To use them, you must enter the Table with the Degree of Latitude at the Head, and with the Minute on the first Column towards the Left-Hand; and in the Angle of Meeting you will have the *Meridional Parts*.

Having the Latitudes of two Places, to find the Meridional Miles or Minutes between them, consider whether the Places be one under the Equinoctial and the other wide thereof; or the one on the one side of the Equinoctial, and the other on the other; or whether they both lie on the same side: For, according to these Positions, there's a threefold Case.

1. When one Place lieth under the Equinoctial, then the Meridional Minutes that are found next under the Degree of Latitude the other Place lieth in, is the Meridional Difference of Latitude, or Latitude enlarged.

2. When one Place hath North Latitude, and the other South, add the Meridional Minutes belonging to each Latitude together, and the Sum is the Meridional Minutes between them.

3. When both Places are towards one Pole, then subtract the Meridional Parts answering to the lesser Latitude, out of those for the greater, and the Remainder will be the Meridional Minutes required.

Examples of these Cases will make them more plain, which shall be these:

*Example 1.*

To find the Meridional Parts or Minutes between the Equinoctial and Latitude  $43^{\circ} 11'$ .

In the Column under 43, and right against 11 Minutes in the Left-Hand Column, stands 2878.2, the Meridional Parts required.

*Example 2.*

Let it be required to find the Meridional Parts between  $25^{\circ} 13'$  South Latitude, and  $51^{\circ} 30'$  North.

Under  $51^{\circ}$  and against  $30'$  is ————— 3616.8  
Under  $25^{\circ}$  and against  $13'$  is ————— 1564.3

The Merid. Parts between the two, are — 5181.1

*Example 3.*

To find the Meridional Minutes between the Latitudes  $32^{\circ} 15'$  North, and  $53^{\circ} 23'$  North.

Under  $53^{\circ}$  and against  $23'$  is ————— 3802.2  
Under  $32^{\circ}$  and against  $15'$  is ————— 2046.1

The Meridional Parts between the Latitudes proposed, are — — — 1756.1

MERLON, in Fortification, is that Part of the Parapet which lies betwixt two Embrasures, being from 8 to 9 Foot long on the Side of the Cannon, and 6 on the Side of the Field; as also 6 Foot high, and 18 thick.

MESARAICK *Veins*, arise from, or are rather enclosed in the *Mesentery*, being Branches of the *Vena Porta*.

MESARÆUM, [*μεσάραιον*, Gr.] the same with *Mesenterium*; whence its Vessels are called as well *Mesaraick* as *Mesenterick*.

MESENTERICK *Arteries*: The upper of which is said to distribute itself among the small Guts, and the under one to go to the lower Part of the *Mesentery*.

MESENTERICK *Plexus* [in *Anatomy*] a Piece of Network form'd by the Branches or Ramifications of the *Par Vagus*. It is formed out of the concurrent Branches of several other *Plexus's*, and sends its nervous Fibres thro' the whole *Mesentery* along with the *Mesaraick* Vessels, which they accompany to the Intestines with various Circumlignations.

MESENTERY, is the Membrane of the *Peritonæum* doubled, enriched with Glandules, Nerves, Arteries, Veins, Chyliferous and Lymphatick Vessels: It is in the middle of the *Abdomen*, and contains the Intestines in a wonderful manner. It has a great Glandule in the middle, called *Pancreas Asellis*; about which are several other less Glandules, to which the milky Vessels of the first Rank tend, from the Intestines and Lymphatick Vessels, from the Liver and other Parts: From these Glandules again the milky Vessels of the second Rank ascend to the Vessel that carries the Mass of Chyle, and discharge themselves into it. *Blanchard*.

MESN, or *Mesn*, a Term in Law, signifying him that is Lord of a *Manor*, and so hath Tenants holding of him; yet himself holds of a superior Lord. It signifies also a Writ, which lieth where there is Lord, *Mesn* and *Tenant*: The *Tenant* holdeth of the *Mesn* by the same Services whereby the *Mesn* holdeth of the Lord; and the *Tenant* of the *Mesn* is distrain'd by the superior Lord, for that his Service or Rent which is due to the *Mesn*.

MESOCOLON, [*μεσώκωλον*, Gr.] is that Part of the *Mesentery* which is continued to the Great Guts, lying in the midst of the Gut *Colon*, whereto it is joined in its whole Course, and in its lowest Border sticks to a Part of the *Rectum*.

MESOLABIUM, [*μεσολαβιον*, Gr.] in Mathematicks, is an Instrument for finding Mean Proportionals.

MESOLABIUM. See *Renati Trans. Fluxi Mesolabium*; cui accessit pars altera de *Analysi & Miscellanea*. *Leodii Eburonum*, 1668. 4to.

MESO-LOGARITHM [of *μέσος*, and *λογαριθμος*, Gr.] the Logarithms of the Co-fines and Co-tangents; are so called by *Kepler*.

MESOPLEURII, [*μεσοπλευριον* of *μέσος*, the Middle, and *πλευρόν*, the Pleura, Gr.] are the Inter-costal Muscles, twenty-two on each side; eleven external, and as many internal.

MESSENGER of the Exchequer: The four Pursuivants in that Court are called by this Name, and their Duty and Office is to attend the Lord Treasurer, and to carry his Letters, Precepts, &c.

MESSUAGE, is a Dwelling-House, with some Land assigned for its Use; and by this Name a Garden, Shop, Mill, Chamber or Cellar may pass, faith *Plowden*, Fol. 169. In *Scotland* it is what we call a *Minor-House*, the principal Dwelling-House within any Barony.

METACARPUS, [*μετακαρπιον*, Gr.] and *Metacarpium*, is the Back of the Hand, made of four oblong little Bones, which expand the Palm of the Hand, and they are called *Post-brachialia*.

METACARPUS, is a Bone of the Arm, made up of four Bones which are annexed to the four Fingers; that which sustains the Fore-finger is the biggest and longest. They are round and long, a little



little convex and round towards the Back of the Hand, and concave and plain towards the Palm: They are hollow in the middle, and full of Marrow; they touch one another only at their Extremities, leaving Spaces in their middle, in which lie the *Musculi interossei*. In the upper End there is a *Sinus*, which receives the Bones of the Wrist, and their lower Extremity is round, and is received into the *Sinus* of the first Bones of the Fingers.

**METACHRONISM** [*μεταχρονισμὸς*, Gr.] an Error in Computation of Time, either in Defect or Excess.

**METACONDYLI**, [*μετακνδύλοι*, Gr.] are the utmost Bones of the Fingers.

**METALS** and *Minerals*. The excellent Promoter of all useful Learning, Bishop *Wilkins*, in his real Character, gives the following Table of Metals.

Metal is a Mineral, for the most part of a Hard Consistence, Close, Ductile, and Fusile; and may be distinguished into

#### I. Perfect.

And this is either,  $\left\{ \begin{array}{l} \text{Natural, or} \\ \text{Factitious.} \end{array} \right.$

#### II. Imperfect.

With Reference to  $\left\{ \begin{array}{l} \text{Metalline Kinds, or} \\ \text{Recrementitious Parts.} \end{array} \right.$

First, *Natural Metals* are such as of themselves grow in the Earth, without any kind of Mixture or other help by the Art of Men. And these are either,

##### 1. More Rare and Precious: Of a

*Yellowish* Colour, most *heavy*; not growing in particular Mines, where it is debased with any drossy Mixture, but found pure either in small Sands, or rocky Branches; and this is *Gold*.

*Whitish* Colour, next in Value to Gold, not subject to Rust, yielding (when struck) a pleasant Sound; as *Silver*.

##### 2. Of a Middle Value, and of a

*Whitish* Colour, and more soft Consistence, as *Tin*: Or of a

*Reddish* Colour, as *Copper*.

##### 3. Of a Baser Value, and more common, are

*Lead*, which is of a yet softer Consistence; a *darkish* Colour, and not *Sonorous*.

*Iron*, which is of an hard Consistence, and of a rusty dark Colour too.

Secondly, *Factitious Metals*; are such as are made by the Art of Man: Of which some are made of

*Copper*, and *Lapis Calaminaris*, as *Brass*. Some of

*Tin*, *Lead*, and *Tin-Glass*, as *Pewter*. Or of *Iron* depurated, by frequent heating, and beating, and boiling with Salts; as *Steel*.

Thirdly, *Imperfect Kinds* of Metal, are either

*Fluid*, as *Mercury* or *Quicksilver*: Or,

*Solid* and consistent. And some of these are used for

*Purging*, and chiefly upwards, as *Antimony*.

Some are used for making of *Pewter*, being of a shining brittle Substance, as *Bismuth* or *Tin-Glass*. Others are used for making of

*Solder*, as *Spelter*, *Zink*, or *Spalt*. And some are made use of for

*Painting*, as *Cinnabar*, *Vermilion*, and *Black Lead*.

Fourthly, *Recrementitious Parts* of Metals, are such as are cast off either in the Preparation of them by

*Melting*; as *Litharge*, which is a kind of Scum arising from the Purification of Silver from Lead; and *Spodium* and *Pompholix*, which fly out from Copper when it is in Fusion, and either fall down again to the Ground, as the former, or adhere to the Roof or Walls, as the latter: Or else they come from the Metal by

*Beating* or Hammering, as the *Scoria*, or Scales; or arise from

*Corruption* either in the general Way, as *Rust*, or after a particular manner, as in the making of *Verdigrase* and *Ceruse*; one from Copper, or Brass, and the other from Lead.

But notwithstanding this Scheme be a good general Summary; yet a good Discourse on this Subject is very much wanting; and indeed, to do it well, will be a very difficult Task: Because in the *Mineral Kingdom* (as Dr. *Woodward* observes in his excellent *Natural History of the Earth*, Part 4.) there is nothing *regular*, *constant*, or *certain*: neither *Colour*, *Figure*, nor their *Place* or *Situation* in the Earth are to be trusted to, or relied upon, so as positively to make any Judgment from thence.

A common *Marchasite*, or *Pyrites*, shall have the Colour and Brightness of Gold or Silver, and yet afford nothing but a little Sulphur and Vitriol; whilst another Body, having only the Resemblance of a Pebble or a Stone, shall have a plentiful Admixture of a valuable Metal in it.

Nothing is more common than to find the same Metal shot also into very different Forms and Figures; as well as to find different kinds of Metal of the same Form and Figure: And a Body which hath the Shape and Appearance of a Diamond, may prove upon Examination, to be nothing but Chrystals or *Selenites*; nay, perhaps only common Salt, or Alum, naturally chrySTALLIZ'd, or shot into that Form.

So also as to their Place in the Earth, there is the same Uncertainty: Sometimes we find them in the Perpendicular Fissures, or Intervals of the *Strata*, sometimes interspersed in the Bodies of the *Strata*, and sometimes in both: Only indeed in the Gems there is this Difference, That the *Topazes*, *Amethysts*, *Emeralds*, &c. which grow in the Fissures, are ordinarily chrySTALLIZED or shot into angular Figures, whereas those found in the *Strata*, are in rude Lumps, only like so many Yellow, Purple, or Green Pebbles; not but that even these that are thus lodged in the *Strata* are also sometimes found chrySTALLIZED, and in the Forms of *Cubes*, *Rhombs*, &c. but then those found in the *Strata*, are easily distinguished from the other, because they are without their *Root*, (as the Jewellers call it) or the Abruptness at their Ends, whereby the others adhere to the Stone or Sides of the Intervals, which

Abruptness



Abruptness is occasioned by their being broken off from thence: And those which are found inclosed in solid Stone, Marble, &c. being difficultly separable from the Stony Matter which adheres to them on all sides, have commonly some of that Matter sticking to them on all their sides; whereby they are distinguished from those found in the *Perpendicular Intervals*, they adhering only by one End, as was above observed.

The same *Metals* are also placed indifferently in all kind of terrestrial Matter, or in *Strata* of very different Natures. They are frequently also variously intermixed one with another; so that 'tis a rare Thing to find any of them pure and simple, but Copper and Iron shall be in the same *Mass*, Gold and Copper, Silver and Lead, Tin and Lead; yea, sometimes all the Six together in one and the same Lump.

'Tis the same thing with *Minerals*; and Minerals and Metals are very often blended and intermixed together.

Now the Knowledge of this may be of good use to undeceive those, who by reading of some Authors, are persuaded, That all Things relating to Metals and Minerals, are transacted by Nature in a most regular and accurate Order, whereas indeed there is nothing like that; and the only standing Test, and distinguishing Characteristick of any Metal or Mineral, must be sought for in the constituent Matter of it, and it must first be brought down to that, before any certain Judgment can be given of it.

Those Metals and Minerals which are repositied in the Bodies of the *Strata*, are either found there in Grains, or small Particles, or else amassed into Balls, Lumps, or Nodules; which Nodules are either of an irregular and uncertain Figure; as the common *Pyritæ*, *Flints*, *Agates*, *Onyxes*, *Pebbles*, *Cornelians*, *Jaspers*, &c. or else they are of a Figure somewhat regular and observable; as the *Belemnites*, the several sorts of *Mineral Coral*, the *Stelechites*, the *Lapis Mucetoides*, vulgarly called *Fungites*: The *Astroites*, or *Starry Stone*; as well that sort with the *prominent*, as that with the concave Stars: The *Selenites*, the echinated chrystalline Balls, with many more analogous Bodies.

Those which are contained in the *Perpendicular Intervals* of the *Strata*, are either such as are there gathered into a Rude Heap, without any particular Form or Order, lying included within the two opposite Walls or Sides of the said Intervals, which, according to their Quantity, they wholly, or partly fill.

In such manner is *Sparre*, and other Minerals usually found; as also the common Ores of Lead, Tin, Iron, and other Metals: or else such as are distinguishable by being of some observable Figure; as the *Sparry Stiræ* or *Iceycles*, called *Stalactitæ*, or rather *Stagonitæ*; the native *Saline Iceycles*, or *Sal Stalactitum*; the *Vitriolum Stalactitum Nativum*; the *Vitriolum Capillare*; the *Alumen Stalactitum* and *Capillare*; *Minera Ferri Stalactica*; which when several of the Cylindrick *Stiræ* are contiguous, growing together, as it were, in one Sheaf, is called *Brush Iron Ore*; the *Argentum Arborefcens* and *Capillare*. To these add also the crystallized Ores and Minerals, viz. the Tin, and mündick Grains, the Iron Rhumbs, crystallized Nitre, Salt, Alum, Vitriol and Sulphur: Of which sort also are the Gems or Stones that are here shut into Cubes, into Pyramidical Forms, or into Angulated Columns, consisting of six Sides, and micro-

nated or terminating in a Point; being either *Opake* or *Pellucid*, or but partly so, and coloured Black, White, Grey, Red, Purple, Blue, Yellow or Green; v. gr. *Chrystal*, the *Pseudo-Adamantes*, the *Cornish* and *Bristol-Stones*, *Crystallized Sparrs*, the *Iris*, the *Amethyfst*, the *Sapphire*, the *Topaz*, the *Emerald*, &c.

As to the Origin and Production of Metals and Minerals, the Doctor from the Light his Observations have given him, comes to these Conclusions.

1. That the far greatest Part of our Metals and Minerals, viz. all such as are now found in the *Strata*, do owe their present Frame and Order to the *universal Deluge*, when the *Strata* of Stone, Earth, Marble, &c. themselves were also formed. At which Time also were all metallick and mineral Nodules whatsoever formed; as well those in rude Lumps, such as the common *Pyritæ*, *Flints*, *Pebbles*, *Agates*, *Onyxes*, *Jaspers*, *Cornelions*, &c. as those of a more observable Figure and regular Shape; as the *Selenites*, *Belemnites*, *Stelechites*, mineral Coral.

2. That the metallick and mineral Matter, now found in the perpendicular Intervals or Fissures of the several *Strata*, of which the Body of the Earth is composed, was all of it originally, and at the Time of the Deluge, lodged in the Bodies of those *Strata*, that it was educed thence, and transmitted into these Intervals since that Time; the Intervals themselves not existing 'till the *Strata* were formed, and afterwards broken, to let the Water from off the Earth. See *Part 2. Consect. 3, 6.* and *Part 3. Sect. 2.* of his *Natural History of the Earth*.

But he supposes, that the Water which is continually ascending from the Abyfs, towards the Surface of the Globe (see *Abyfs*, and the Word *Springs*), continually pervading the Bodies of the *Strata*, detaches out of their Pores and Interstices, such metallick and mineral Corpuscles, as lie loose in its way (and which are withal so small as to be capable of passing through those Interstices) forcing them along with it to the perpendicular Intervals; where having more Room, and a freer Passage than before, it deserts them and leaves them in those Intervals; and that this way all the mineral and metallick Metals now found in those Places, were brought thither, and there do still grow and increase.

But that these in the *Strata* do not, nor cannot grow, but on the contrary, are continually lessened and diminished, by so much as hath been conveyed into their perpendicular Intervals, and hath been brought forth on the Surface of the Earth by Springs, Rivers, and Exhalations from the Abyfs, ever since the Deluge,

The Doctor supposes also, That the *Bitumen*, which is found in Lumps, or coagulated Masses, in some Springs; and which in others is found floating on the Surface of the Water in the Form of an Oil (called by Naturalists *Naphtha* and *Petroleum*;) That the Salt wherewith the *Salinæ* or Salt Springs abound, the Vitriol, Alum, Nitre, Sulphur, Sparr, and other Minerals, wherewith the *Acidulæ*, or medicinal Springs are impregnated; all these Minerals, he saith, were first lodged in the *Strata* of Stone, Coal, Earth, &c. and have since been educed thence, and conveyed into those Springs, by the Water pervading those *Strata* in its Passage from the Abyfs towards the said Springs. See a much larger Account of this Matter under the Word *Fossils*.



METAL, a Word frequently used about a Piece of Ordnance, or great Gun: The Outside or Surface of her is called, The *Superficies of her Metals*: When the Mouth of a great Gun lies lower than her Breech, they say, She *lies under Metal*; but if she lies truly level, point-blank, or right with the Mark, they say, She *lies right with her Metal*.

METALS [in *Heraldry*.] There are two Metals used by way of Colours, *viz.* Gold and Silver; the first is called *Or*, and the second *Argent*; these are represented in Painting by Yellow and White.

METALS *Lines*: On *Gunter's Sector* are sometimes placed two Lines called the *Lines of Metals*; they are noted with the Characters of the seven Metals,  $\odot$ ,  $\text{C}$ ,  $\Psi$ ,  $\text{H}$ ,  $\text{Q}$ ,  $\text{J}$ , and  $\text{U}$ ; and their Use is to give the Proportions between the several Metals in their Magnitudes and Weight, and by them such Problems as these are solved.

1. In Bodies of the same Figure of different Metals, by the Magnitude of one given, to find the Magnitude of the rest.

Take the Magnitude given out of the Lines of Solids, and open the Sector till it be applied right in its proper Points; then will the Parallels taken between the corresponding Points of the other Metals, and measured on the Solids, give their several Magnitudes.

2. In Bodies of different Metal, but equal Magnitude, having the Weight of one, to find that of the rest.

This Problem is the Converse of the former, but not in direct but reciprocal Proportion; apply the Weight given, taken out of the Lines of Solids into the Sector in its proper Points belonging to the Metals of the other Body, so the Parallel taken from the Point's belonging to the Body given, and measured in the Lines of Solids, shall give the Weight of the Body required.

3. A Body being given of any one Metal, suppose a Sphere of Lead of 16 d. and whose Diameter is  $a$  (let  $d$  and  $a$  signify any Magnitudes or Lengths) to make another like it and of equal Weight, but of another Metal, as suppose Iron.

Take out the Diameter  $a$ , and apply it in the Lines of Metals in the Points of  $\text{H}$  belonging to Lead; then will the Parallel between the proper Points in  $\text{J}$ , be the Diameter of the Iron Sphere required: And this compared with the other Diameter in the Line of Solids, will give 23 d. for the Magnitude of the Body required.

4. A Sphere of Lead being given, whose Diameter is  $a$ , to make another Sphere of any other, as of Iron, whose Weight shall be determined; *v. gr.* that shall weigh thrice as much.

Apply the Diameter  $a$  over in the proper Points of  $\text{H}$ ; and then the Parallel between the proper Points of  $\text{J}$  will give the Length of the Diameter of an equal Sphere of Iron; and this tripled will be the Diameter required.

See *Webster's Metallographia*. Lond. 1670. 4to.

*Alonso Barba's Art of Metals*, English'd by the Earl of Sandwich, Part I. II. in 8vo. 1674.

Sir *John Bettus's Fleta minor*; or, the Laws of Art and Nature, in knowing, judging, finding, refining, &c. the Body of confined Metals.

VOL. II.

*Georgius Agricola de Re metallica*, Fol.

METALLURGY, [*μεταλλουργία*, Gr.] is the Working or Operation upon Metals, in order to render them most fine, hard, bright, beautiful, serviceable or useful to Mankind.

METAPEDIUM, the same in the Foot that *Metacarpus* is in the Hand.

METAPHOR, [*μετάφορα*, Gr.] a Trope in *Rhetorick*, by which we put a strange and remote Word for a proper Word, by reason of its Resemblance with the Thing of which we speak: As a King is called the Head of his Kingdom, because he commands the Members of the Politick Body, as the Head does the Natural Body.

METAPHRENUM, [*μετάφρενον*, Gr.] is that Part of the Back which comes after the *Diaphragm*. *Blanchard*.

METAPTOSIS, [*μετάπλωσις*, Gr.] is the degenerating of one Disease into another, as of a *Quartan Ague*, into a *Tertian*; and on the contrary, of an *Apoplexy* into a *Palsy*, &c.

METAPHYSICKS [*μεταφυσικά*, Gr. of *μετά* beyond, and *φυσική* natural, or *φύσις* Nature, Gr.] A Branch of Science, which by some is defined to be that which considers Spirits and immaterial Beings; which others chuse to distinguish by the Name of *Pneumaticks*; others call it *præter-natural*, *post-natural*, or *trans-natural Philosophy*; others call it *Ontology* or *Ontosophy*; i. e. the Doctrine of Being in general; i. e. of Being *quatenus*, Being or Being in the Abstract.

METAPLASM [*μεταπλάσμις*, Gr.] a grammatical Figure, a Mutation or Change made in a Word, by adding, retrenching, or changing a Letter or Syllable of it.

METASTASIS, [*μετάστασις*, Gr.] is when a Disease goes from one Part to another; which happens to apoplectick People, when the Matter which affects the Brain is translated to the Nerves.

METATARSUS, [of *μέτα* and *τάρσος*, Gr.] is composed of five little Bones, connected to those of the first Part of the Foot, which immediately succeeds the Leg.

METATHESIS [*μετάθεσις*, Gr.] a Transposition, a grammatical Figure whereby the Letters of a Word, or the Words of a Sentence, are transposed or shifted out of their natural Situation.

METEOROLOGY [*μετεωρολογία*, of *μετέωρα* and *λέγω*, Gr.] the Doctrine of Meteors, explaining their Origin, Formation, Kinds, Phænomena, &c.

METEOROSCOPE [*μετεωροσκοπιον* of *μετέωρα*, and *σκόπεω* of *σκέπτομαι*, Gr. to view.] An Instrument for observing and determining the Distances, Magnitudes, and Places of the heavenly Bodies.

METEORS, [*μετεωρα* of *μετά* beyond, and *αίρω*, Gr. to lift up] (according to the *Cartesians*) are certain various Impressions made upon the Elements, exhibiting them in different Forms, and are called *Meteors* from their Elevation; because for the most part, they appear to be high in the Air; and they are either Fiery, Airy, or Watery.

Fiery Meteors, are such as consist of a fat, sulphurous kindled Smoke, whereof there are several Kinds; as *Ignis Fatuus*, *Trabs*, *Ignis Pyramidalis*, *Draco Volans*, *Capra Saltans*, *Thunder* and *Lightning*, &c.

Airy Meteors, are such as consist of flatuous and spirituous Exhalations, as *Winds*, &c.

Watery Meteors, consist of Vapours or Watery Particles, by the Action of Heat separated from each other, and variously modified, as *Rain*, *Dew*, &c.



Dr. Woodward, in his *Natural History of the Earth*, p. 208. supposes the Matter of *Meteors* to be in good measure of a mineral Nature; and that the mineral Particles contained in the *Strata* of the Earth, are raised up by the subterranean Heat or Fire, along with the Vapours ascending from the Abyss, and pervading those *Strata*, and especially at such times as the Sun's Power is so great, as to penetrate the exterior Parts of the Earth, and therefore help to mount them up into the Atmosphere. These Sulphureous, Nitrous, and other light and active mineral Particles do form Meteors in the Air, and particularly are the Cause of *Thunder* and *Lightning*, &c. and other fiery Compositions there.

METHOD, or *Disposition*, is that Action of the Mind, by which we range various Ideas, Judgments and Ratiocinations upon one and the same Subject, in that Order which is most proper for its Explanation; and a right Method of Enquiry after Truth, or the Prosecution of any Demonstration, will be found to consist also in a regular Train of Arguments and Consequences rightly disposed in their just and natural Order. If you will believe *Des Cartes*, he saith, in his Book *De Methodo*, That he was able to master the greatest Depths in *Geometry*, by only observing constantly these four following Rules in his Studies.

*First*, Never to admit any thing for Truth, and to treasure it up in the Mind as such, unless we be demonstratively assured that it is such.

*Secondly*, To divide the Difficulties of the Problem, or Matter inquired after, into such a proper Number of Parts, as is most convenient for its Resolution.

*Thirdly*, To observe exact Order and Method in our Thoughts and Inquiries, so as to begin with the plainest and easiest Things first, and then to proceed on gradually to Things more and more difficult.

*Fourthly*, To be sure not to slip, over-look, or omit any thing, either in the Difficulties to be solved, or in the means of Inquiry.

These are indeed very good Rules, and I question not were very serviceable to him in his *Geometrical Inquiries*; but the Sight of our Countryman *Harriot's Algebra*, did him as much Service as all of them.

In *Mathematical Inquiries*, there are two general Methods commonly made use of, the *Analytical* and the *Synthetical*; which see: And to which may be added, the *Zetical* and *Poristical* Methods; which you will find under those Words.

METHODISTS; Physicians who adhere to the Doctrine of *Galen* and the Schools, in opposition to *Empiricks* and *Chymists*.

METOCHE [in antient *Architecture*] the Space or Intervals between the Dentils. *Vitruvius*.

METONICK Cycle, the same as *Metonick Period*.

METONICK Year, or *Period*, is the Space of 19 Years; in which time, the *Lunations* return, and happen as they were before; 'tis sometimes called, *The Great Metonick Year*, and is the same with the *Cycle of the Moon*.

METONYMY, [*μετωνυμία*, Gr.] or *Transnominatio*, (a Figure or Trope in *Rhetorick*) is the putting of one Name for another, or expressing a Thing by another Name, than which properly belongs to,

it; as if we should say, *All the World reads Cicero*; *Cæsar ravaged the Gauls*: it would be plain, what we intended, viz. That *the World reads Cicero's Works*; *Cæsar's Army ravaged the Gauls*.

METOPA, [*μετοπή*, Gr.] in *Architecture*, is the Interval or Space between every Triglyph in the Frize of the *Dorick Order*. The Ancients used to adorn these Parts with carved Works or Paintings, representing the Heads of Oxen, Vessels, Bassons, and divers other Instruments that were used in their Sacrifices.

METOPS, the same with *Metopa*.

METOPOSCOPY [*μετωποσκοπία* of *μέτωπον*, the Forehead, and *σκοπέω* of *σκέπτομαι*, Gr. to view] the Art of discovering the Temperament, Inclinations, and Manners of Persons, by viewing the Lines in their Faces.

METRENCHYTA, [*μετρεγγύτης*, of *μήτρα* the Womb, and *ἐγχύω*, Gr. to pour in] is an Instrument wherewith Liquors are injected into the Womb.

METRICE [in the antient *Musick*] that Part conversant about the Quantities of Syllables; or that considered them as long or short.

METTESHIP, *Metteschep*, *Mettenscep*, seems to have been anciently a Fine or Penalty paid by the Tenant to his Lord for his Neglect or Omision of doing his customary Service. Perhaps it should be written *Mittenscep* from the Saxon *Mitten*, to measure, and *ceap*, Goods or Chattels.

MEZANINE [in *Architecture*] an *Entresole*.

MEZZOTINTO; a particular Manner of engraving Figures on Copper. It is performed by hatching or punching the Surface of the Plate all over with an Instrument, first one way, and then across, &c. till the Face of the Plate be intirely furrow'd with Lines; and then drawing the Design on the Face, and expunging the Dents or Furrows with Burnishers, Scrapers, &c. where the Lights of the Piece are to be, more or less as they are to be stronger or fainter, leaving those Parts that are to represent the Shadows or Deepenings of the Draught, Black.

MIASMA, [*μιάσμα*, Gr.] is a contagious Infection in the Blood and Spirits, as in the *Plague*, &c.

MICROCOUSTICKS, [of *μικρός* little, and *αἰσῶ*, Gr. to hear] the same with *Microphones*.

MICROCOSM, [of *μικροκοσμος*, of *μικρός* and *κόσμος*, Gr. the World] The Body of a Man is called the *Little World*, as a kind of Compendium of the Greater.

MICROGRAPHY, [*μικρογραφία*, of *μικρός* and *γράφω*, Gr. to describe] is the Description of the Parts and Properties of such very small Objects as are only discernable by Means of the Microscope. On this Subject the late Dr. *Hook* hath written designedly in his *Micrography*, as hath also Dr. *Power*; and *Leuenhoeck*, in 2 Vols. in Quarto, *Latin*; in which, as well as scattered up and down in many other Books written on other Subjects, a very noble Treasure of useful Discoveries is to be found, and all made by means of the Microscope.

MICROMETER, [of *μικρός* and *μέτρον*, Gr. Measure] is an Instrument made of Brass, being a Movement with a Plate, or Face, divided like a Clock or Watch, with an Index or Hand, which (being turned) moves two sliding Plates of Brass with Hairs, and counts on the Plate the Revolves or Turns of the endless Screw. This Instrument is fitted to a large Telescope, and used in *Astronomy*, to find the Diameters of the Stars or Planets.

MICROMETER. In *Philos. Trans.* N<sup>o</sup> 25, you have from Mr. *Richard Townley*, an Account of the

Micrometer



Micrometer invented by Mr. *Gascoigne*; and by this Instrument he found the Moon's Distance and Parallax from two Observations of her meridional and horizontal Diameter, before Mr. *Auzout* took this Matter into Consideration: Which Micrometer Mr. *Townley* had, and is described by Dr. *Hook* in *Philos. Trans.* N<sup>o</sup> 29. and the manner how it is to be applied to a Telescope shewed. And Mr. *Flamsteed*, in N<sup>o</sup> 96. saith, that by the Micrometer and a Telescope of but 14 Foot, he could take the Diameters of the Planets and their Distances from the Fixed Stars, to a Second almost. This Instrument is now brought to very great Perfection and ready Use by the excellent Mathematical Instrument-maker Mr. *John Rowley*, of late under *St. Dunstan's Church* in *Fleetstreet*. See its Use in finding the Sun's horizontal Parallax, under the Word *Sun* in this Volume.

A Micrometer is made of Brass; A B C g is a rectangular Brass Frame, the Side A B being about 3 Inches long, and the Side B C, as likewise the opposite Side A g, are about 6 Inches; and each of these three Sides are  $\frac{3}{4}$  of an Inch deep. The two opposite Sides of this Frame are screwed to the circular Plate; which we shall speak of by and by.

The Screw P having exactly 40 Threads in an Inch, being turned round, moves the Plate G D E F, along two Grooves made near the Tops of the two opposite Sides of the Frame; and the Screw Q having the same Number of Threads in an Inch as P, moves the Plate R N M Y along two Grooves made near the bottom of the said Frame, in the same Direction as the former Plate moves, but with half the Velocity as that moves with. These Screws are both at once turned, and so the said Plates moved along the same way, by means of a Handle turning the perpetual Screw S, whose Threads fall in between the Teeth of Pinions on the Screws P and Q. Note, Two and a half Revolutions of the perpetual Screw S, moves the Screw P exactly once round.

The Screw P turns the Hand a, fastened thereto over 100 equal Divisions made round the Limb of a circular Plate, to which the above-named two opposite Sides of the Frame are screwed at Right Angles; the Teeth of the Pinion on the Screw P, whose Number are 5, takes into the Teeth of a Wheel on the back-side of the circular Plate, whose Number are 25. Again, on the Axis of this Wheel is a Pinion of two, which takes into the Teeth of another Wheel moving about the Centre of the circular Plate, without side the same, having 50 Teeth. This last Wheel moves the lesser Hand b once round the above-named circular Plate, in the  $\frac{1}{100}$  Part of the time the Hand a is moving round; for because the Number of Teeth of the Pinion on the Screw P are 5, and the Number of Teeth of the Wheel this Pinion moves round are 20, therefore the Screw P moves four times round in the same time that the Wheel of 20 Teeth hath moved twenty-five times round; and consequently the Screw P, or Hand a, must move a hundred times round in the same time as the Wheel of 50 Teeth, or the Hand b, hath moved once round.

It follows from what has been said, That if the circular Plate W, which is fastened at Right Angles to the other circular Plate, be divided into 200 equal Parts, the Index x, to which the Handle is fastened, will move five of these Parts in the same time that the Hand a has moved one of the

hundred Divisions round the Limb of the other circular Plate; and so by means of the Index x, and Plate W, every fifth Part of each of the Divisions round the other Plate may be known.

Moreover, since each of the Screws P and Q have exactly 40 Threads in an Inch, therefore the upper Plate G D E F will move 1 Inch, when the Hand a hath moved forty times round; the four thousandth part of an Inch, when the said Hand hath moved over one of the Divisions round the Limb; and the twenty-thousandth part of an Inch, when the Index x hath moved one part of the 200 round the Limb of the circular Plate W; and the under Plate R N M Y, half an Inch, the two-thousandth part of an Inch, and the 10000th part of an Inch, the same way, in the said respective times. Hence, if the under Plate, having a large round Hole therein, be fixed to a Telescope, so that the Frame may be moveable together with the whole Instrument, except the said lower Plate, and the strait smooth Edge H I, of the fixed narrow Plate A B I H, as likewise the strait smooth Edge D E of the moveable Plate G D E F, be perceivable through the round Hole in the under Plate, in the Focus of the Object-Glass; that when the Handle of the Micrometer is turned, the Edge H I of the fixed narrow Plate A B I H, as likewise the strait smooth Edge D E of the moveable Plate G D E F, be perceivable thro' the round Hole in the under Plate, in the Focus of the Object-Glass; then when the Handle of the Micrometer is turned, the Edge H I of the narrow Plate A B I H fixed to the Frame, and D E of the moveable Plate, will appear thro' the Telescope equally to accede to, or recede from each other; and so these Edges will serve to take the apparent Diameters of the Sun, Moon, &c. The Manner of doing which, is this: Suppose in looking at the Moon thro' the Telescope, you have turned the Handle till the two Edges D E and H I are opened, so as to just touch or clasp the Moon's Edges; and that there was twenty-one Revolutions of the Hand a to compleat that Opening, first say, As the focal Length of the Object-Glass, which suppose 10 Feet, is to Radius, so is one Inch to the Tangent of an Angle subtended by one Inch in the Focus of the Object-Glass, which will be found 28' 30". Again; because there are exactly 40 Threads of the Screws in one Inch, say, If forty Revolutions of the Hand a give an Angle of 28' 38", What Angle will twenty-one Revolutions give? The Answer will be 15' 8"; and such was the Moon's apparent Diameter; and so may the apparent Diameters of any distant Objects be taken.

It is to be observed, that the Divisions upon the Top of the Plate G D E F, are diagonal Divisions of the Revolutions of the Screws, with diagonal Divisions of Inches against them, and so as the said Plate slides along, these Diagonals are cut by Divisions made on the Edge of the narrow Plate K L, fixed to the opposite Sides of the Frame by means of two Screws. These diagonal Divisions may serve to count the Revolutions of the Screws, and to shew how many there are in an Inch, or the Parts of an Inch.

In order to determine the apparent Diameters of the Planets, as also to measure other small Distances in the Heavens accurately, there have been several sorts of Micrometers apply'd to the Focus's of Telescopes: the Construction of the most simple of those Micrometers, is as follows: In the Focus of a Telescope fit a Brass or Iron Ring A B with female Screws, diametrically opposite to each other:

Into



Into these Female Screws insert Male Screws A E and F B, of such Lengths as that they may be turn'd into the Tube so as to meet each other; and with this Instrument very small Spaces in the Heavens may be accurately measured; for when any two Objects view'd thro' the Tube, appear contiguous to the Screws, if the Telescope be turn'd about to two other Points, that do also exactly appear contiguous to the Screws, they remaining in the same Position as before, if the Distance asunder in those two latter Points be known or can be measured, the same will be the Distance asunder of the first two Objects. To determine how many Seconds answer to each Thread of those Screws, observe two Points in the Heavens, whose Distance is accurately known, and turn the Screws till they appear contiguous with those known Objects; and observe the Number of Threads corresponding to that Interval; then by the Rule of Three it may easily be determined how much of that, or any other Interval agrees to every Thread of the Screw; thus, by saying, As the Number of the Threads of the Screws required to measure the known Distance, is to the known Distance in Seconds, so is one Thread to a fourth Number; which fourth Number is the Number of Seconds answering to each Thread of every Screw. After the same manner may a Table be made, by which the apparent Distances of Objects, or the apparent Diameters of the Planets, may be found by Inspection, having the Number of Threads of the Screws that measure that Interval.

N. B. The Screws should be as exactly made as possible.

MICROPHONES, [of *μικρὸς*, and *φωνή*, Gr. *the Voice*] are Instruments contrived to magnify small Sounds, as *Microscopes* do small Objects.

MICROSCOPE, [of *μικρὸς*, and *σκοπέω*, Gr. *to view*] is an optical Instrument, which by extremely magnifying (as they say) any Object, helps us to discover the minute Particles of which Bodies are composed, and the curious Frame and Contexture of them.

*To make very small single Eye-glasses for Microscopes.*

Get some very small Silver-wire, and double it up and down like a Skein of Thread, in order to make a Wick (for a Lamp) of a moderate Size; then fill a Lamp with *Spirit of Wine*, well dephlegmated, and use the Silver-wire instead of a Cotton-wick: Then having ready some fine Glass beaten, powdered, and sifted very small, and well washed and dried, take some of it on the Point of a Silver Needle filed very small, and wetted a little with Spittle, and holding it in the Flame of the Lamp, turn it about 'till it melt, (as it will soon do) into a fine round Globule: You must hold it in the Flame no longer than 'till it come to its *round Figure*, lest you burn it: The only Difficulty is in giving it that Roundness exactly, but Practice will soon learn you the Knack of it; they must be cleansed afterwards by rubbing them awhile on soft Leather. *Philos. Transf.* N° 141.

Those *Microscopes* that are made with single Convex Glasses, must have the Object placed in one *Focus* of the Glass (or rather a little nearer), and the Eye must be in the other *Focus* on the other side.

These kind of *Microscopes*, when the Glasses are well made, do magnify exceedingly: Such are our very famous Mr. *Mellen's* Glasses, which, I believe,

are the best of any in the World of this kind: And such are those of Mr. *Lewenboeck* of *Delft* in *Holland*, by which so many great Discoveries have been made.

But there is more than one great Inconvenience in these Glasses, *viz.* To magnify much, the Object must be so near, that it must almost touch the Glass; 'tis also very difficult to fit the Object true to the Glass, and when fitted, to fix it so; and but a very small Part of the Object can be seen at a time. But then they being contrived to carry in the Pocket, are very ready, and will be of vast Use on many Occasions.

The best Glasses of this kind that ever I saw, are made by the above-mentioned Mr. *Mellen*, who formerly lived in *Abchurch-Lane*.

In *Philos. Transf.* N° 42, is an Account of a *Microscope* of *Eustach. Divini* (which is also treated of by *Faber* in his *Opticks*, *Prop.* 46.) and which I have in some measure experimented myself to be a very good Method of disposing the Glasses. He uses, instead of a common double Convex Eye-glass, two Plane Convex ones, which are so placed as to touch one another in the middle of their Convex Surface; by which means the Glass will take in more of any Object, will represent it flat, and not crooked, and will magnify also (as they call it) very much. This Glass had four several Lengths (made by Draws); at the least Length, which was 16 Inches, it magnified Lines 41 times bigger than they appear to the naked Eye; at the second Length 90 times; at the third Length 111 times; at the fourth Length 143.

As to the Method of making the same Glass magnify differently, at different Lengths, Mr. *Marshall* hath brought it to bear very well in his small Pocket *Microscopes*; and this I take to be a good Improvement, which he hath added to the Glasses of *Campani*, which are made after that manner, but with only one Degree of magnifying with one and the same Glass.

In *Philos. Transact.* N° 221. there is an Account of several microscopical Experiments, by one Mr. *Stephen Gray*; where he speaks of making *Microscopes* with a Globule of Water only, put into an Hole made in a small Brass Plate, which I myself have often tried; and were it not for the trembling Motion of the Fluid, it would do very well.

He saith also, That by applying a small Globule of Pepper-water, &c. to his bare Eye, (*i. e.* by fixing it on the Surface of his Eye) he could in a darkened Room, by Candle-light or Moon-light, or by looking thro' a small Hole in a piece of Paper, discern the *Animalcula* which were in it exceedingly magnified; and oftentimes, when the Drop of the Fluid was round and well defined, very distinct and plain.

In N° 232. Mr. *Gray* gives a farther Improvement of his *Water Microscope*.

*A Description of Mr. Marshall's Double Microscope.*

*This Microscope consists of Three Glasses;*

The Eye-Glass *W*.  
The Middle-Glass *A*.  
And the Object-Glass *C*.

*B.* Is the Cover or Lid, to keep out Dust from the Eye-glass *W*.

*X.* Is the Place for the Eye.

*W.* A Screw where the Eye-glass lies.

*A 1.* A Screw where the Middle-Glass lies.

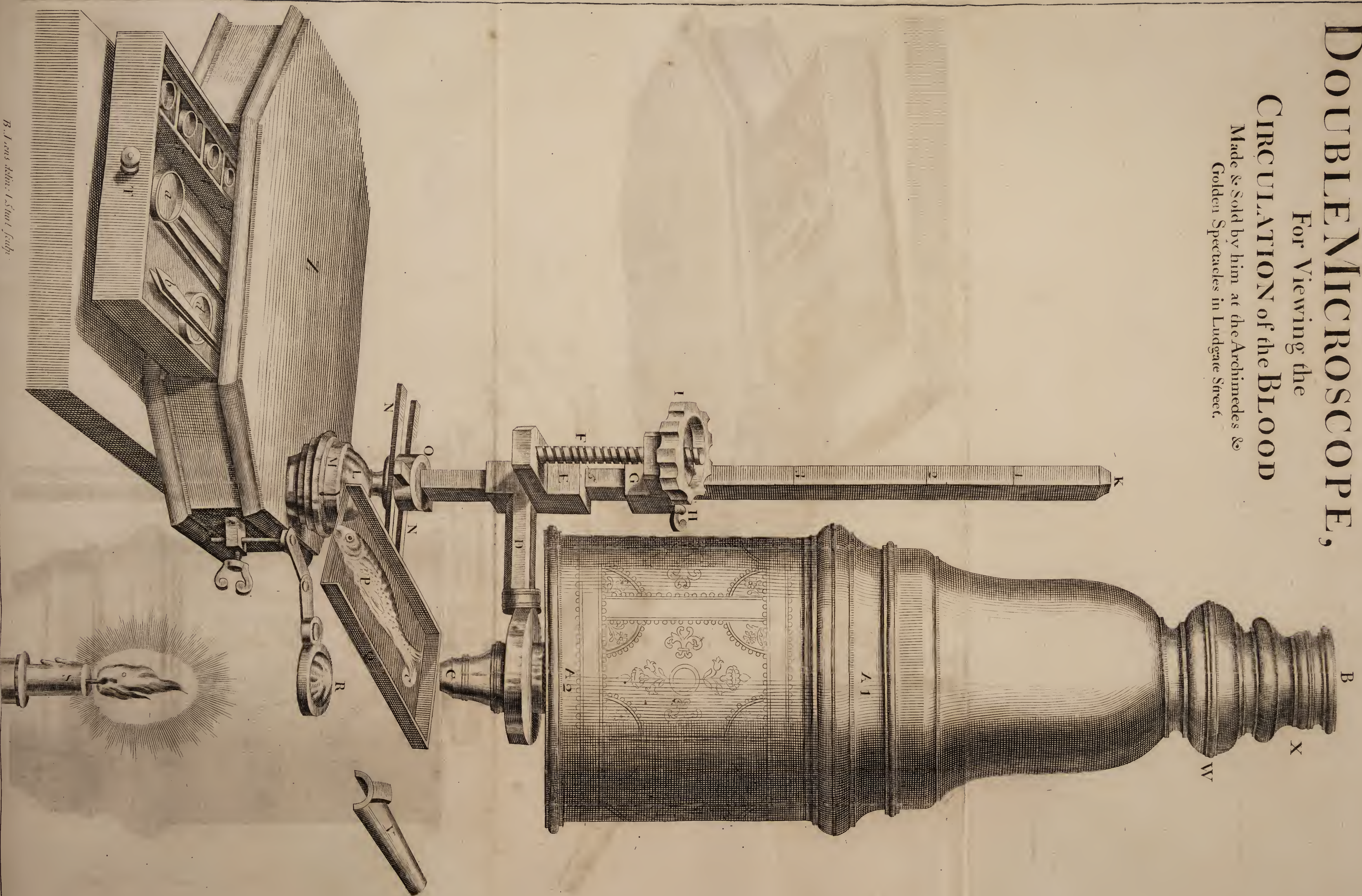
*A 2.* The



# JOHN MARSHALL'S New Invented DOUBLE MICROSCOPE,

For Viewing the  
CIRCULATION of the BLOOD

Made & Sold by him at the Archimedes &  
Golden Spectacles in Ludgate Street.









## A 2. The Draw.

C. The Object-Glass fix'd in a Brass Button, to screw on or off, as Occasion serves.

Z. The Frame or Basis on which the *Microscope* stands firm.

T. A small Drawer in the Frame or Basis, with a Ledge or Till in it, having six Partitions to hold so many several Object-Glasses, one magnifying more than another, and fixed in Brass Cells ready to screw on at C, and marked 1, 2, 3, 4, 5, 6. These Partitions are also marked.

1, 2, 3, 4, 5, 6. The other Part of the Drawer serves to hold the Object-plate (a); a Pair of small Nippers (b), to take up or handle any Object conveniently; another Object-plate (d), having one side White, and the other Black, to fix your Objects upon, as Black upon White, and White Objects on Black.

L. M. A Brass Ball and Socket, on which the whole Body of the *Microscope* is moveable, so as to lie in any Position for the Light.

K. O. A square Brass Pillar on which the *Microscope* is moveable up and down, by means of the Collar E, into which the Arm D (holding the *Microscope*) is continued.

G. Another Brass Collar sliding up and down on the Pillar K. O. having a small Screw H, by which it is, as Occasion serves, fix'd fast to the said Pillar, at any Height.

I. A large Brass Nut, in whose Centre is a Female Screw, fitted to the Male Screw F, which is fixed in the Collar E: By the turning of which Nut I, (the Collar G being first fix'd to the Pillar by the Screw H) the *Microscope* is rais'd up or down on the Pillar, and made to come nearer, or go farther from the Object: And which is also a very great Advantage, the Axis of the *Microscope* is always kept perpendicular to that Point of the Object, over which it was first placed; so that here is not the Inconvenience which occurs in other Glasses, of often losing the Sight of the Object, by screwing the Glass higher or lower.

Q. A Glass Object-Plate fix'd in a Brass Frame, whose Arm N. N. is fix'd to the Pillar by means of the Nut O. The Arm N. N. hath in it a Slit, by which 'tis easily put on, or taken off the Pillar, and by which it may be fix'd upon it at any Distance.

P. A small Fish lying on the Glass-Plate, that the Circulation of the Blood may be seen in part of the Tail-fin, at (c).

R. A Convex-Glass, by whose Help a bright Spot of Light is brought from a Candle at S, standing on the Ground while the *Microscope* stands on the Edge of a Table or Stool; which Spot of Light (c) serves to render the Circulation more conspicuous.

V. A Lead Coffin to be put on the Fish, to hinder it from springing away, and moving his Tail out of the Light.

1, 2, 3, 4, 5, 6, Are Marks on the Pillar K. O. which shew you the Distance that the Object-Glass must be from the Object you look upon, according as the Object-Glasses you make use of, magnify more or less. Thus, for Instance, If you use the Object-Glass 5 or 6, (either of which will shew the Circulation of the Blood) you must fix the upper Edge of the Collar E, at the Mark 5 or 6 on the Pillar. And then will the *Microscope* be very near its exact Distance from the Object; so that by a small Turn or two

of the Nut I, either way, you may soon exactly fit it to your own Eye, and place the Object in its true distinct Basis.

By this *Microscope*, Liquors also may be very commodiously examined; for if you place a small Drop of any Liquor on the Glass-plate just in the middle of the Spot of Light (c), the Parts of it will become very visible, and its *Animalcula*, if it have any, will be discovered. And thus may the Eels in Vinegar, the small Creatures in Black Pepper-water, or in Waters where Wheat, Barley, &c. have been infused, the Eels and other small living Creatures in Puddle-water, be as plainly seen as by almost any other *Microscope*.

And one Thing I ought not to omit to speak on this Occasion; which is, That I have often with this Glass, seen the Circulation of the Blood in the Fins of the Tail of Tadpoles; and indeed more conspicuously here than in any other Creature: For the Fins growing all round the Tail, and coming but a little way out beyond the Body of it, both the Ejaculation of the Blood out by the Arteries, and its Return again by the Veins, is much quicker than in the Tails of Fishes; and abundance more Streams, Turns and Windings of the moving Blood are here visible, than I could ever see in any other Animal. To which I may add, That the Creature will live a good while out of the Water, and will lie very still.

The Object and the Image in the distinct Base, being reciprocal (as Mr. *Molineux* shews, p. 102. of his *Dioptricks*), the Image there may be formed larger than the Object, on which depends the Doctrine of the *Double Microscope*.

Which Instrument, I believe, was first contrived, at least fitted for Use and Observation; by Dr. *Hook*, F. R. S. and a Description of it is published in his *Micrographia*.

Since that, Mr. *John Marshal*, at the *Archimedes* in *Ludgate-street*, hath brought it to a very good Degree of Perfection: And I take his *Double Microscope* here described, in all Respects, to be the most useful, handy, and ready Instrument of this kind.

I have had *Mellen's* Glasses, and seen *Lewenboeck's* and *Campani's*, but I would sooner have the *Double Microscope* than any of them; and the Price is much easier.

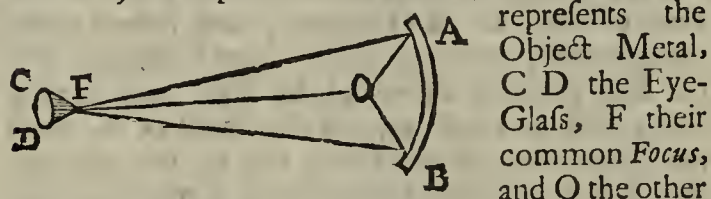
MICROSCOPE: By those excellent Observations and Experiments which the admirable Sir *Is. Newton* hath made on Colours, he shews Ways to conjecture very accurately of the Sizes of the component Particles of Bodies by their Colours; and in the Description of those, he tells us (*Book 2. Part 3. p. 64.*) he hath been the more particular, because it is not impossible but that Microscopes may (if not done already) at length be improved to that Perfection, as to discover the Particles of Bodies on which their Colours depend. For, saith he, if those Instruments are or can be so far improved, as with sufficient Distinctness to represent Objects five or six hundred times bigger than at a Foot Distance they appear to the naked Eye, I should hope that we might be able to discover some of the greatest of these Corpuscles; and by one which would magnify three or four thousand times, perhaps they might all be discovered, but those which produce Blackness. And if this could be attain'd to, (*viz.* by Glasses to discover the constituent Particles of Bodies) he fears it would be the utmost Improvement of the Sense of *Seeing*; for it seems impossible to see the most secret and noble Works of



Nature *within* the Corpuscles, because of the Transparency of these Corpuscles.

The same Gentleman, in *Philos. Transf.* N<sup>o</sup> 88. from the Difference he had found between compounded and simple Colours, takes Occasion to communicate a Way for the Improvement of Microscopes by Refraction; *viz.* by illuminating the Object in a darkened Room with Light of any convenient Colour not too much compounded; by which Means the Microscope will with Distinctness bear a deeper Charge and a larger Aperture.

And in N<sup>o</sup> 80, he saith, that he hath sometimes thought of making a Microscope which should have, instead of an Object-Glass, a *Reflecting Piece of Metal*. For these Instruments seem as capable of Improvements as Telescopes; and perhaps more, because but one Piece of reflecting Metal is requisite in them; as is plain from this Figure; where A B



represents the Object Metal, C D the Eye-Glass, F their common Focus, and O the other Focus of the Metal in which the Object is placed.

The Description and Use of Mr. Scarlet's Sett of Pocket-Microscopes, &c. mentioned in the Preface.

This Sett of *Microscopes* has *Nine* different *Magnifying-Glasses*, *Eight* of which may be used with two different Instruments, for the better applying them to various Objects: One of these Instruments is represented, *Fig. I.* A A A A, and is made of Ivory; it hath three thin Brass Plates, E E, and a Spring of Steel H within it; to one of the thin Plates of Brass is fixed a Piece of Leather F, with a small Furrow G . . . . both in the Leather and Brass to which it is affixed. In one End of this Instrument there is a long Screw D, with a *Convex-Glass* C, placed in the End of it: In the other End there is a hollow Screw o o, wherein any of the *Magnifying-Glasses* M, are screwed when they are to be made use of. The *Nine* different *Magnifying-Glasses* are all set in Ivory, *Eight* of which are set in the manner express'd at M. The greatest Magnifier is marked upon the Ivory wherein it is set with N<sup>o</sup> 1, the next N<sup>o</sup> 2, and so on till N<sup>o</sup> 8. The 9th Glass is not marked, but set in the manner of a little Barrel Box of Ivory, as in *Fig. II.*

e e A flat Piece of Ivory, whereof there are *Eight* belonging to this Sett of Microscopes, (tho' any one who has a mind to keep a Register of Objects, may have as many of them as he pleases) in each of which there are three Holes f f f, wherein three or more Objects are placed between two thin *Glasses*, or Talks, when to be used with the greater Magnifiers.

The other Instrument, *Fig. III.* is made of Brass or Prince's Metal, with Joints P P P, to turn easily any Way with a small Pair of Tongs G G, which open at the Points K, by pressing together the two Heads of the Pins I I for taking up of Objects: At the other End of these Tongs G G, is screwed on a round Piece of Black Wood H, with a Piece of Ivory let into it, for placing opaque Objects on, according to their Difference of Colour.

Upon the End L there is a Screw, into which the *Glass* set in the Barrel Box may be screwed; when the others are to be used, there is a Ring R of Brass to be screwed on the End L; into which Ring all the other *Glasses* M may be screwed: So when any Object is taken up in the Points of

the Tongs K, or laid upon the other End H, it may very easily (as one who sees the Instrument will perceive) be applied to the true Distance of any of the *Glasses* M, by the Help of the Joints P P P, and by means of the Screw C, with the Wheel D, *Fig. III.* which will bring the Object to the Exactness of the *Centre* or true Distance, being regulated by a Spring N.

The Use of the first mention'd Instrument, *Fig. I.* A A A A is thus: Take one of your flat Pieces of Ivory e e, or *Sliders*, (if you please to call them so) and slide it in betwixt the two thin Plates of Brass E E, in the Body of the Microscope; so that the Object you intend to look upon be just in the middle, remarking that you put that Side of the Plate e e, where the Ring is, farthest from your Eye: Then you are to screw into o o, (the hollow Screw in the End of the Body of your Microscope) the 3<sup>d</sup>, 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup>, or 7<sup>th</sup> *Magnifying-Glass* M; which being done, while you are looking through your *Magnifying-Glass* upon the Object, you are to screw in or out, the long Screw D, *Fig. I.* in the other End of the Body of your Microscope, till you bring your Object into the true Distance, which you will know by seeing the Object clearly and distinctly: But seeing that in the greater Magnifiers you can see but a small Part of the Object, *viz.* the Legs or Claws of a Flea; while you are looking upon any Part of the Object, if ye take hold of the End of the Plate or Slider e e, whereon the Object lies, and move it gently, you may see the whole Object successively, or any Part of the Object you please; and if that Part of the Object you design to look upon be out of the true Distance, remember your End Screw D, *Fig. I.* can always bring it in, by screwing it nearer or farther off.

After this manner may be seen all transparent Objects, Dust, Liquids, Chrystals of Salt, small Insects, such as Fleas, Mites, &c. If they be *Insects* that will creep away, or such Objects as one intend to keep, they may be placed between the two *Register-Glasses* f f. For by taking out (with the Point of a Penknife or small Pliers) the Ring that keeps in the *Glass* f f, where the Object lies, they will fall out of themselves; so you may lay the Object between the two hollow Sides of them, and put the Ring in as it was before: But if the Object be Dust or Liquids, a small Drop of the Liquid, or a little of the Dust laid on the outside of the *Glass* f f, and applied as before, will be seen very easily.

As to the *First, Second, and Third Magnifying-Glasses*, being marked with a  $\times$  upon the Ivory wherein they are set, they are only to be used with those Plates or Sliders that are also marked with a  $\times$ , wherein the Objects are placed between two thin Talks, because the Thickness of the *Glasses* in the other Plates or Sliders, hinder the Object from approaching to the *Centre* or true Distance of these greater Magnifiers. But the manner of using them is the same with the former. Only remember to be careful when you put in or pull out the Plate or Slider e e, whereon the Object lies, or move it from one Object to another, not to let it rub your *Magnifying-Glass*, which is done by unscrewing a little the End Screw D, *Fig. I.* when ye put in or pull out your Plate, or move it from one Object to another.

For seeing the *CIRCULATION* of the BLOOD at the Extremities of the Arteries and Veins, in the transparent



transparent Parts of *Fishes, Eels, &c.* There are two *Glass Tubes*, the one bigger, and the other lesser, as express'd at gg, wherein the *Fish* is to be put; when these *Tubes* are to be used, you are to unscrew the End Screw D, Fig. I. in the Body of the *Microscope*, until the *Tube* gg, can be receiv'd easily into that little Cavity G of the *Brass-Plate*, fastened to the Leather F, under the other two thin Plates of Brass E E: When the *Tail* of your *Fish* lies flat to the *Glass Tube*, set it opposite to your *Magnifying-Glass*, and by screwing in or out your End Screw D, Fig. I. as is said before, you may easily bring it to the true Distance, and see the Blood circulate with great Pleasure.

If you would see the *Blood circulate* in a *Frog's Foot*, chuse such a *Frog* as will just go into your *Tube*, then with a little Stick, &c. expand the *Hinder Foot* of the *Frog*, and apply it close to the Side of the *Tube*, observing that no Part of the *Frog* hinders the Light coming on its *Foot*, and when you have it at the just Distance, by Means of the Screw D, Fig. I. as abovesaid, you will see the rapid *Motion* of the *Blood* in its *Vessels*, which are very numerous in the transparent thin Membrane that's between the *Frog's Toes*: For this Object the 4th and 5th *Magnifiers* will do very well; but you may see the Circulation in the *Tails* of *Water-Newts* with the 6th and 7th *Glass*, by reason the Globules of the Blood of those *Newts* are as big again as the Globules of the Blood of *Frogs* or small *Fish*, as has been taken Notice of in N. 280. of the *Philosophical Transactions*, Page 1184.

N. B. The *Circulation* cannot be so well seen by the First, Second, and Third *Magnifiers*, because the Thickness of the *Glass* wherein the *Fish* lies, hinders the Approximation of the Object from the true Focus of the *Glass*.

S, Fig. I. is a little Ivory Screw, upon which the Handles of the *Brass Instrument* W, Fig. III. may be screwed, and serve for a Handle to this Ivory one also.

The *Glass*, plac'd in the Manner of a Barrel Box, Fig. II. is only to be used when the *Brass Instrument* (or in your Hand) being the least *Magnifier*, for greater Objects, such as *Flies* and common *Insects*, &c. A Hole being made in the Side of this Box, Fig. II. whereby it may be screwed on the Point L, Fig. III. of the *Brass Instrument*, remembring to put the End b next to your Eye, and the other to the Object; so if you take up an *Insect* in the Point of the Tongs K, or lay any opaque Object on H the other End, you may approach them to the true Distance by means of the Joints and Screws spoken of before C, D, P, N, Fig. *Ibid*.

In the viewing of *Objects*, one ought to be careful not to hinder the Light from falling upon them, by the Hat, Peruke, or any other Thing, especially when they are to look upon opaque Objects: For nothing can be seen with the best of Glasses, unless the Object be in a due Distance, with a sufficient Light.

The best Lights for the Plates or Sliders, where the Object lies between the two Glasses, is a clear Sky-light, or where the Sun shines on any white thing, or the Reflection of the Light from a Looking-glass. The Light of a Candle is likewise good

for the viewing of very small Objects, though it be a little uneasy to those who are not practis'd in *Microscopes* to find out the Light of the Candle.

By what is here said, it's hop'd that the Use of this *Microscope*, easy of its self, will be much easier to those that use it; yet it cannot be doubted of this, as of all other Instruments of this Nature, but that *Usus plura docebit*.

For the Conveniency of those who would *Draw*, or make any *Sketches* or *Designs* after *Microscopical* Objects, they may also have a Pedestal to fix the two Instruments above described, and make them stationary to any convenient Light. This Pedestal may be placed on a Table, &c. and after the Object and Light are fixed, as many Persons as please may view the Object, without any Trouble or Difficulty in finding the Light.

The rest of the annexed *Figures* were drawn by this *Microscope* from several Objects.

A the *Artery*, B the *Vein*, C their communicant Canal, by which the Blood is seen passing from the former to the latter, in the Tail of the *Fish*, express'd at gg.

D the *Animalcula* in *Semine masculino*, by the first *Glass*.

E one of the *Farina* of the Flower of *Mallows*, which magnified is the *Area* represented at D.

F the Branch of an *Artery*, G that of a *Vein*. The intermediate Spaces shew the Manner they communicate unto one another, in the Sides of the Lungs of *Frogs*, *Newts*, &c.

H one of the Feathers of a *Moth's* Wing.

MIDDLE Latitude, in Navigation, is half the Sum of any two given Latitudes; as suppose the two Latitudes were 50°. 30'. and 45°. 20'. the middle Latitude will be 47°. 55'.

There is a Method of working the several Cases of Sailing by *Middle Latitude*, which nearly agrees with *Mercator's* or *Wright's* way; and it is performed without the Table of Meridional Parts, either by the Tables of *Logarithms* or by *Gunter's* Scales. Of this Method you have a short *Synopsis* in Mr. *Jones's Navigation*, p. 71.

MID-SHIP-MEN, are Officers aboard a Ship, whose Station when they are on Duty, is some on the Quarter-Deck, others on the Poop, &c. Their Business is to mind the *Braces*, to look out, and to give about the Word of Command from the Captain and other superior Officers. They do also assist on all Occasions both in sailing the Ship, and in storing and rummaging the Hold. They are usually Gentlemen, who having served their Time as Volunteers, are now upon their Preferment.

MILDEW, a dewy Moisture which falls on Plants, and by its continuance on them for want of being drawn up by the Heat of the Sun, corrodes, gnaws and spoils the internal Substance of the Plant by its Acrimony, and hinders the Circulation of the Sap, by which means the Leaves begin to fade and the Blossoms and Fruit are much injured.

MILE [*Mille passus* L.] A long Measure, whereby we usually express the Distance between Places.

Geogra-



Geographical MILE contains a thousand Geometrical paces. The Mile is of different Extent in different Places.

*Casimir* has made a curious Reduction of the Miles or Leagues of the several Countries in Europe into Roman Feet, which are equal to the Rhinland Feet generally used throughout the North.

	Feet.
The Mile of Italy,	5000
of England,	5454
of Scotland,	6000
of Sweden,	30000
of Muscovy,	3750
of Lithuania,	18500
of Poland,	19850
of Germany the Small,	20000
the Middle,	22500
the largest,	25000
of France,	5250
of Spain,	7090
of Burgundy,	6000
of Flanders,	6666
of Holland,	8000
of Persia call'd the Parasant,	8750
of Egypt.	25000

MILIARIES *Glandulae*, are those very small and infinitely numerous Glands which secrete the Sweat and the Matter that exudes in insensible Perspiration. See *Skin*.

MILIARIS *Herpes*. See *Herpes*.

MILIARY Fever, a Malignant Fever, when the Skin is besprinkled with little purple Spots or Pustles, resembling grains of Millet.

MILITARY *Architecture*, the same with *Fortification*.

MILITARY Execution, is delivering a Country up to be ravaged and destroyed by the Soldiers, when it refuses to pay Contribution, &c.

MILITARY Exercises, are the Evolution or various Manners of exercising and ranging Soldiers.

MILITARY Column, a Column on which was Engraven a List of the Troops of the Roman Army, or the Number of Soldiers employ'd in an Expedition.

MILITARY Fever, a Malignant Fever frequent in Armies by reason of bad Diet, Lodging, &c.

MILKY-WAY, or *Via Lactea*, the *Galaxy*, is a broad white Path or Track, encompassing the whole Heavens, and extending it self in some Places with a double Path, but for the most Part with a single one. Some of the Antients, as *Aristotle*, &c. imagin'd that this Path consisted only of a certain Exhalation hanging in the Air; but by the Telescopical Observations of this Age, it hath been discovered to consist of an innumerable Quantity of Fixed Stars, different in Situation and Magnitude; from the confused Mixture of whose Light, its white Colour is supposed to be occasioned. It passes through the Constellations of *Cassiopeia*, *Cygnus*, *Aquila*, *Perseus*, *Andromeda*, Part of *Ophiucus*, and *Gemini*, in the Northern Hemisphere; and in the Southern, it takes in Part of *Scorpio*, *Sagittarius*, *Centaurus*, the *Argo Navis*, and the *Ara*.

*Metrodorus*, and some *Pythagoreans*, thought the Sun had once gone in this Track, instead of the Ecliptick; and consequently, that its Whiteness proceeds from the Remains of his Light. As the *Galaxy* is composed of an Infinity of small Stars, so it hath usually been the Region in which new

Stars have appeared: As the new Star in *Cassiopeia*, which was first seen A. D. 1572. that in the Breast of the *Swan*, and another in the Knee of *Serpentarius*; and several others, which have appeared for a while, and then become invisible again.

MILLAINS, according to Mr. *Wingate*, are the third Subdivision of the Primes in *Gunter's Line*, and express the 1000th Parts of such Primes.

MILLION [in *Arithmetick*] ten hundred Thousand, or a Thousand times a Thousand, expressed thus, 1000000.

MIMOSÆ *Plantæ*, the same with *Sensitive*; which see.

MINE, in Fortification, is a Hole dug or made by a Pioneer under the Rampart, or under the Face of the Bastion, whereto there are several oblique and winding Passages: When it is finished, divers Barrels of Powder are placed therein, together with a Train or *Saucidge*; and the Quantity of Powder is proportioned to the Height and Weight of the Body which is to be blown up. There are also Mines sprung in the Fields, which are called *Fougades*.

The Ally or Passage of a Mine is usually about four Foot square; at the end of which is the Chamber of the Mine, as they call it. The farther it is carried on, the more it is subject to be discovered by the Enemy; therefore 'tis best not to aim at Mining too far, and to make a new one where the former takes no Effect.

MINE-Dyal, is a Box and Needle, with a Brass Ring divided into 360 Degrees, with several Dyals graduated thereon; generally thus made for the Use of Miners.

MINERALS, are hard Bodies dug out of the Earth or Mines (whence the Name) being in part of a Metalline, and in part of a Stony Substance, and sometimes with some Salt and Sulphur intermixed with the other. Of these see a large Account under the more general Word *Fossils*. See also *Stones* and *Minerals*.

MINIM, a Term in Musick; see *Notes* and *Time*.

MINIATURE, } a fine delicate Manner of  
MIGNATURE, } Painting, consisting of fine points or dots instead of Lines, done on Velum, with very thin, simple Water-Colour.

MINIMA *Naturalia*, are such Particles of Matter, which tho' they have each a determinate Shape and Bulk, yet are too minute to be singly sensible. These are supposed to be entire, and undivided, and to be perfectly solid; and are the same with what in another Word are called *Atoms*, because of their supposed Indivisibility.

MINIMENTS, or rather *Muniments*, in Law, are the Evidences or Writings, whereby a Man is enabled to defend the Title of his Estate. And some say this Word *Miniments* includes all manner of Evidences.

MINION, a sort of Cannon, is either *Large* or *Ordinary*.

The *Large Minion*, or one of the longest Size, has its Bore  $3\frac{1}{4}$  Inch Diameter, and is 1000 Pound Weight: its Load is  $3\frac{1}{4}$  Pound of Powder; its Shot 3 Inches Diameter, and  $3\frac{3}{4}$  Pound weight; its Length is 8 Foot, and its level Range 125 Paces.

The *Ordinary Minion*, its Bore is 3 Inches in Diameter, and weighs about 800 or 750 Pound weight: Its 7 Foot long; its Load 2 Pound and a half of Powder; its Shot near 3 Inches Diameter, and



and weighs 3 Pounds 4 Ounces; and it shoots point-blank 120 Paces.

MINIUM, or *Red-lead*, is the common Calx of Lead calcined for 3 or 4 Hours in a Reverberatory Furnace, till it turn to a Red Colour.

MINIUM or *Red-lead*. Mr. Ray at the End of his Collect. of *Engl. Words*, gives this Account of the making of *Minium*. First they take Lead and waste it in an Oven or Furnace, by bringing it to a Substance almost like *Litharge*, and by stirring it about with an Iron Rake or Hoe. Then they take it out and grind it with two Pair of Stones, which deliver it from one to another; and there is a Mill which moves at once six Pair of these Stones. When 'tis thus reduced to a Powder, they wash it, and then put it into an Oven or Reverberatory Furnace, where by continual stirring with a Rake or Hoe of Iron, it comes to its Colour in 2 or 3 Days. But the Fire must not be violent, for then it will clod and change Colour. The Iron Rake is hung or poised by a Hook, else it would be too heavy to be moved by one Man.

MINT, is the Place where the King or Queen's Coin is formed, be it of Gold or Silver: The chief Mint of *England* is in the *Tower of London*; of which the present Officers are (1.) The *Warden* who is the chief, and is to receive the Bullion, and oversee all the other Officers. (2.) The *Master Worker*, who receives the Bullion from the *Warden*, causes it to be melted and delivered to the *Moniers*, and takes it from them again when coined. (3.) *Comptroller*, who is to see that the Money be made to the just Assize, and to oversee and controll the Officers, if the Money be not as it ought to be. (4.) The *Assay Master*, who weighs the Silver and Gold, and sees whether it be Standard. (5.) The *Auditor*, who takes all the Accounts. (6.) The *Surveyor of the Melting*, who is to see the Silver cast out, and that it be not alter'd after it's deliver'd to the *Melter*; which is after the *Assay-Master* hath made Trial of it. (7.) The *Clerk of the Irons*, who is to see that the Irons be clean and fit to work with. (8.) The *Graver*, who graveth the Dies and Stamps for the Coinage of the Money. (9.) The *Melters*, who melt the Bullion before it comes to coining. (10.) The *Blanchers*, who anneal, boil, and cleanse the Money. (11.) The *Porters* who keep the Gate of the Mint. (12.) The *Provost of the Mint*, who provides for all the Moniers, and oversees them. And lastly, The *Moniers*, some of which shear the Money, some forge it, and some stamp or coin it, and some round it and mill it.

MINOR, a Term in Law, signifying one in Nonage, Minority, or under Age: But more properly an Heir Male or Female, before they come to the Age of One and twenty; during which Minority their Actions are invalid, &c. Yet a *Minor* may present, as Patron to an Ecclesiastical Benefice.

MINOVERY, a Trespass committed in the Forest by something that is a Man's handy Work, as an Engine to catch Deer, &c.

MINUTE, is the 60th Part of a *Degree* or *Hour*; so that every Hour, or Degree of any great Circle is divided into 60 Minutes, every Minute into 60 Seconds, each Second into 60 Thirds, &c.

In astronomical Tables MINUTES are express'd by acute Accents thus ', seconds by two thus "", thirds by three thus "".

MINUTE. [in *Architecture*] is a 30th Part or Division of a Model.

MINUTE [in *Weight*] is the 24th Part of a Grain.

MIRROR, } A Body which represents the  
MIRROUR, } Objects presented to it by Reflection. In the most confin'd Sense, a *Mirroure* is a smooth Surface of Glass, having Tin or Quick-Silver laid on the Backside, which shews the Images of such Objects as are oppos'd to it.

MIRROR [in *Catoptricks*] is any polish'd Body that is impervious to the Rays of Light, and which consequently reflects it equally; and thus smooth polished Metals or Water in a deep Well or River, are rank'd in the Class of Mirrours.

Light reflected from any Mirroure or Speculum, makes the Angle of Incidence equal to that of Reflection.

Hence a Ray of Light, as A B, Fig. 1. falling perpendicularly on the Surface of a Speculum, will be reflected back upon itself, which we find by experience it actually does.

From the same Point of a Mirroure therefore there cannot be several Rays reflected to the same Point, since in that Case all the Angles of Incidence must be equal to the same Angle of Reflection CBG, and therefore to each other, which is absurd. Nor can the Ray A B be reflected into two or more Points, since in that Case all the Angles of Reflection would be equal to the same Angle of Incidence A B F, which is likewise absurd.

From every Point of a Mirroure are reflected Rays thrown on it from every Point of a radiant Object.

Since then Rays coming from different Parts of the same Object, and striking on the same Point of the Object, cannot be reflected back to the same Point, the Rays which flow from different Points of the same radiating Object, are again separated after Reflection; so that each Point shews whence it came.

Hence it is, that the Rays reflected from Mirrours exhibit the Objects to view. Hence also it appears, that rough uneven Bodies must reflect the Light in such Manner, as that Rays coming from different Points will be blended or thrown confusedly together.

Mirrours are either Plane, Concave, Convex, Cylindrical, Conical, Parabolical or Elliptical.

Plain Mirrours, or Specula, are those which have a plain or flat Surface.

These by a popular Word we call Looking-Glasses.

In a plain Mirroure, every Point of an Object, as A Fig. 2. is seen in the Intersection of the Cathetus of Incidence A B, with the reflected Ray C B.

Hence, as all reflected Rays meet with the Cathetus of Incidence in B, by whatever reflected Rays the Point A be seen, it will still appear in the same Place; consequently any number of Persons viewing the same Object in the same Mirroure, will all see it in the same Place behind the Mirroure. And hence it is, that the same Object has only one Image, and that we don't see it double with both Eyes.

The Distance of the Image B, from the Eye C, is compounded of the Ray of Incidence A D, and the reflected Ray C D, and the Object A radiates reflectedly in the same Manner as it would do directly, were it removed into the Place of the Image.



The Image of a radiant Point B, appears just so far behind a plain Mirrour, as the radiant Point is before it.

Hence if the Mirrour A G be placed Horizontal, the Point A will seem so much below the Horizon, as it is really elevated above it; consequently, erect Objects will appear as if inverted, and therefore Men standing on their Feet as if on their Heads; or if the Mirrour be fastned to the Ceiling of a Room, parallel to the Horizon, Objects on the Floor will appear above the Ceiling as much as they really are below it, and that uplide down.

In a plain Mirrour, the Images are perfectly similar, and equal to the Objects; and hence their Use as Looking-Glasses.

In a plain Mirrour, things on the right Hand appear as on the left, and *Vice versa*.

Hence also we have a Method of Measuring any inaccessible Altitude by means of a plain Mirrour.

Thus the Mirrour being placed horizontally in C, Fig. 3. retire from it till such time as the Top of the Tree be seen therein; Measure the Height of the Eye D E, the Distance of the Station from the Point of Reflection E C, and the Distance of the Foot of the Tree from the same; then to E C, C B, and E D, find a fourth Proportional A B. This is the Altitude sought.

If a plain Mirrour be inclined to the Horizon in an Angle of 45 Degrees, an Object Perpendicular to it will appear Parallel, and an horizontal Object Perpendicular.

And hence the Eye being placed beneath the Mirrour, the Earth will appear perpendicularly over it; or if placed over it, the Earth will appear perpendicularly under it. Hence also a Globe descending down a Plane a little inclined, may, by means of a Mirrour be exhibited as mounting up a vertical Plain, to the great Surprize of such as are unacquainted with Catoptricks.

And hence we have a Method of representing ourselves as if flying.

For a Mirrour inclined to the Horizon under an Angle of 45°, we have observed will represent vertical Objects as if Horizontal; consequently a large Mirrour being so dispos'd, as you advance toward it, you will seem to move horizontally, and nothing will be wanting to the Appearance of flying, but to strike out the Arms and Legs. It must be added however, that as the Floor is elevated along with you, your Feet will still be seen to walk as along a vertical Plane. To deceive the Eye entirely, therefore it must be kept from the Feet.

If the Object A B Fig. 4. be parallel to the Speculum C D, and be equally distant from it with the Eye, the reflecting Line C D will be half the Length of the Object A B.

And hence to be able to see the whole Body in a plain Mirrour, its Height and Breadth must be half your Height and Breadth; consequently, the Height and Breadth of any Object to be seen in a Mirrour, being given, we have also the Height and Breadth of the Mirrour wherein the whole Object will appear, as the same Distance with the Eye.

Hence also, as the Length and Breadth of the reflecting Part of the Speculum, are Subduple of those of the Object to be reflected; the reflecting part of the Mirrour is to the Surface reflected in a Subquadruple Ratio. Consequently, the reflect-

ing Portion being a constant Quantity; if in any Place you see the whole Body in a Mirrour, you will see it in every other Place, whether you approach nearer or recede farther from it.

If several Mirrours, or several Fragments, or Pieces of a Mirrour, be all disposed in the same Plane, they will only exhibit an Object once.

If two plain Mirrours, as X Y, and Z X, Fig. 5. be join'd at an Angle X; the Eye O, placed within that Angle, will see the Image of an Object A placed within the same, as often repeated as there may be Catheti drawn determining the Places of the Images, and terminated without the Angle Y X Z.

Hence, as the more Catheti terminated without the Angle, may be drawn as the Angle is more acute, the acuter the Angle, the more numerous the Images. Thus Z. Traber. found at an Angle of one third of a Circle, the Image was represented twice or thrice, at  $\frac{1}{4}$  thrice at  $\frac{2}{5}$  five times, at  $\frac{1}{12}$  twelve times.

Further, if the Mirrours be placed upright, and so contracted; or if you retire from them, or approach to them, till the Images reflected by them coalesce, or run into one, they will appear monstrously distorted: Thus if they be at an Angle somewhat greater than a right one, you will see it with only one Eye; if the Angle be less than a right one, you will see three Eyes, two Noses, two Mouths, &c. At an Angle still less, the Body will have two Heads. At an Angle somewhat greater than a right one, at the Distance of four Feet, the Body will be headless, &c. Again if the Mirrours be placed the one Parallel to the Horizon, the other inclined to it, or declined from it, it is easy to perceive that the Images will be still more Romantic. Thus, one being declined from the Horizon to an Angle of 144 Degrees, and the other inclined to it; a Man sees himself standing with his Head to anothers Feet.

Hence it appears how Mirrours may be manag'd in Gardens, &c. so as to convert the Images of those near them into Monsters of various Kinds: And since Glass Mirrours will reflect the Image of a lucid Object twice or thrice; If a Candle, &c. be placed between the Mirrours, it will be multiply'd an infinite number of times.

On these Principles are founded various Catoptric Machines, some of which represent Objects infinitely multiply'd and distorted; others infinitely magnify'd, and set at vast Distances.

Convex Mirrours are those whose Surface is Convex. Note, by Convex Surfaces, Authors generally mean such as are spherically Convex.

There are divers Methods used by divers Artists; particularly as to the Matter, or Composition. One of the best that is known, is given us by *Wolffius* thus.

Melt one part of Tin, and another of Marcasite together, and to the Melted Mass add two parts of Mercury; as soon as the Mercury begins to evaporate into Smoak (which it presently does) the whole Compost is to be thrown into cold Water, and when well cool'd, the Water decanted off. The Mixture is then to be strain'd through a Linnen Cloth two or three fold; and what is thus secerned, pour'd into the Cavity of a Glass Sphere: this Sphere is to be turned gently round its Axis till the whole Surface is cover'd; the rest being reserved for future Use.

If the Sphere were of colour'd Glass, the Mirrour will be so too.

And



And in the same Manner may Conic, Elliptic, Cylindric, and other Mirrours be made.

In a spherical convex Mirrour, the Image of a radiant Point appears between the Centre and the Tangent; but nearer to the Tangent than the Centre.

Hence, the Distance of the Object from the Tangent is greater than that of the Image. And, consequently, the Object is further distant from the Speculum than the Image.

If the Arch  $BD$  Fig. 6. intercepted between the Point of Incidence  $D$ , and the Cathetus  $AB$ ; or the Angle  $C$  form'd in the Centre of the Mirrour by the Cathetus of Incidence  $AC$ , and that of Obliquation  $FC$ , be double the Angle of Incidence; the Image  $G$  will appear on the Surface of the Speculum.

If the Arch intercepted between the Point of Incidence, and the Cathetus; or the Angle  $C$  formed in the Centre of the Mirrour by the Cathetus of Incidence, and the Cathetus of Obliquation, be more than double the Angle of Incidence; the Image will be without the Mirrour.

If the Arch intercepted between the Point of Incidence, and the Cathetus; or the Angle form'd in the Centre of the Mirrour, by the Cathetus of Incidence, and that of Obliquation be less than double the Angle of Incidence, the Image will appear within the Speculum.

In a convex Mirrour, a remoter Point,  $A$ , Fig. 7. is reflected from a Point  $F$ , nearer the Eye  $O$ , than any nearer Point  $B$  in the same Cathetus of Incidence.

Hence, if the Point of the Object  $A$ , be reflected from the Point of the Mirrour  $F$ ; and the Point of the Object  $B$  from the Point of the Mirrour  $E$ ; all the intermediate Points between  $A$  and  $B$  will be reflected from the intermediate Points of the Speculum between  $F$  and  $E$ . Consequently  $FE$  will be the Line that reflects  $AB$ .

Hence also, a Point of the Cathetus  $B$ , seems at a greater Distance  $Cb$  from the Centre  $C$  than a more remote one  $A$ .

A nearer Point  $B$  Fig. 8: not in the same Cathetus with a remoter,  $H$ , is reflected to the Eye  $O$ , from a nearer Point of the Speculum, than the remoter  $H$ .

Hence, if the Point of an Object  $A$ , be reflected from the Point of a Mirrour  $C$ ; and the Point of the Object  $B$ , from the Point of the Speculum  $D$ , all upon the same Point  $O$ : all the intermediate Points between  $A$  and  $B$  will be reflected from all the intermediate Points between  $C$  and  $D$ . Consequently, the Image  $FG$ , of the Object  $BA$ , is contain'd between the Cathetus  $BE$ , and  $AE$ .

In a spherical convex Mirrour, the Image is less than the Object.

And hence the Use of such Mirrours in the Art of Painting, where Objects are to be represented less than the Life.

In a convex Mirrour, the more Remote the Object; the less its Image: And again, the smaller the Mirrour, the less the Image. In a convex Mirrour, the Right Hand is turn'd to the Left; and the Left to the Right: And Magnitudes perpendicular to the Mirrour, appear topsy turvey.

The Image of a right Line perpendicular to the Mirrour, is a right Line; but that of a right Line either oblique to the Mirrour, or parallel thereto, is convex.

Rays reflected from a convex Mirrour diverge more than if reflected from a plane Mirrour.

Hence Light, by being reflected from a spherical Mirrour, is weakned; and, consequently, the Effects of the reflected Light are weaker than those of the direct, hence also, Myopes see remote Objects more distinctly in a convex Mirrour, than they do directly.

Rays reflected from a convex Mirrour of a smaller Sphere, diverge more than if reflected from a larger. Consequently, the Light is more weaken'd, and its Effects are less considerable in the former Case than the latter.

Concave Mirrours are those whose Surface is concave.

Note, by Concave, Authors commonly mean spherically Concave.

The Manner of preparing or making concave Mirrours.

First, a Mould is to be provided for casting them. In order to this, take Clay well dry'd, pulverize and sift it; mix it up with Water, and then strain or filter it; with this, work up Horse-Dung and Hair shred small, till the Mass be sufficiently tough; to which, on occasion, may be added Charcoal-dust well sifted.

Two coarse Molds are then prepared of a gritty Stone, the one Concave, the other Convex, which are to be ground on one another with wet Sand between till such time as the one perfectly fits the other. By this means a perfect spherical Figure is acquir'd.

The Mass prepared before, is now to be extended on the Table by means of a wooden Roller, till it be of Thickness proper for the Mirrour; and then being strewn'd with Brick-Dust to prevent its sticking, it is laid over the convex Mould, and so gets the Figure of the Mirrour. When this is dry, it is cover'd with another Lay of the same Mass; which once dry'd, each Cover, or Segment of the hollow Sphere made of Clay, is taken off. The innermost of the two being laid aside, the Stone Mould is anointed with Grease prepared from Chalk and Milk, and the outer Cover again put over it.

Lastly, the Joining being cover'd over with the same Clay whereof the Cover is form'd, the whole Mould is bound together with Iron-Wire; and two Holes cut through the Cover, the one for the Melted Matter of the Mirrour to be poured through, the other for the Air to escape at, to prevent the Mirrour's being spoiled with Bubbles.

The Mould thus prepared; eight parts of Copper, one of *English* Tin, and five of Marchasite are melted together; a little of the Mixture is taken out with a Ladle, and if it be too red, when cold, more Tin is put in; if too white more Copper. The Mass is then poured into the Mould before prepared; and so assumes the Figure of a Mirrour.

Some with ten Parts of Copper mix four of *English* Tin, a little Antimony and Sal Armoniac, stirring the Mass about as long as any Fumes arise from it. Others have other Compositions; many of which are described by *Schottus* and *Zaknius*.

The Mirrour being thus cast, is cemented to a Wooden Frame, and thus work'd to and fro over the Convex Stone Mould, first with Water and Sand; and, lastly without Sand, till it be fit for polishing. The Stone Mould is then cover'd with Paper, and that smear'd over with *Tripoly* Dust and Calx of Tin: over which the Mirrour is work'd to and fro till it have got a perfect Polish. And in the same Manner are Glass Mirrours polished, excepting that the Convex Surface is there work'd in the concave Mould.

When



When the Mirrours are very large, they are fix'd on a Table, and first ground with a gritty Stone, then with Pumice, then with fine Sand, by means of a Glafs cemented to a Wooden Frame, and lastly rubb'd with Calx of Tin and Tripoly Dust by a wet Leather.

For concave Mirrours of Glafs; the Mould is made of Alabaster: The rest, as in Metal Mirrours.

Laws and Phænomena of concave Mirrours.

If a Ray, as *K j*, Fig. 9. fall upon a concave Mirrour *L j*, under the Inclination of 60 Degrees, and parallel to the Axis *AB*; the reflected Ray *j B* will concur with the Axis *AB* in the Pole of the Glafs *B*. If the Inclination of the incident Ray be less than 60 Degrees, at that of *E*, the reflected Ray *E F* will concur with the Axis at the Distance *B F*, which is less than a fourth part of the Diameter. And universally, the Distance of the Point *F*, wherein the Ray *H E* concurs with the Axis, from the Centre *C*, is to half the Radius *CD* in the Ratio of the whole Sine, to the Cosine of Inclination.

Hence it is gathered by Calculation, that in a concave spherical Mirrour, whose breadth subtends an Angle of 6 Degrees, parallel Rays meet after Reflection in a part of the Axis less than one Thousand four Hundred fifty seventh part of the Radius: if the Breadth of the concave Mirrour be 12, 18, 24, 30, or 36 Degrees; the part of the Axis wherein the parallel Rays meet after Reflection is less than  $\frac{1}{32}$ ,  $\frac{1}{16}$ ,  $\frac{1}{8}$ ,  $\frac{1}{4}$ ,  $\frac{1}{2}$  of the Radius.

And on this Principle it is that Burning Glasses are built. For since the Rays diffused through the whole Surface of the concave Mirrour, after reflection are contracted into a very small Compass; the Light and Heat of the parallel Rays must be prodigiously increased thereby, viz. in a duplicate Ratio of the Breadth of the Mirrour, and the Diameter of the Circle wherein all the Rays are collected: And since the Sun's Rays are, as to any purposes on Earth, parallel, no wonder concave Mirrours should burn with so much violence.

From this same Principle is likewise deduced a Method of representing the Images of Objects in a dark Room; a lucid Body being placed in the Focus *F*, of a concave Mirrour, *HBC*; the Rays after Reflection become parallel. Hence an intense Light may be projected to a vast Distance, by a lighted Candle, &c. placed in the Focus of a Concave Mirrour. Hence also, if the parallel Rays be received by another Concave Mirrour, they will again concur in its Focus, and burn.

*Zabnius* mentions an Experiment of this kind made at *Vienna*, where two Concave Mirrours, the one six, the other three Foot Diameter, being placed about 24 Feet apart, with a Live-Coal in the Focus of the one, and a Match and Tinder in the other, the Rays of the Coal lighted the Candle.

If a lucid Body be placed between the Focus *F*, and the Mirrour *HCB*, the Rays after Reflection will diverge from the Axis *B G*. Whence it follows that Light is weakned by Reflection.

If a lucid Body be placed between the Focus *F*, and the Centre *I*, the Rays after Reflection will meet in the Axis beyond the Centre.

Hence if a Candle be placed in *G*, its Image will be in *K*; if it be placed in *K*, its Image will be in *G*; in the intermediate Points between *G* and *K* the Section of Light will be a Circle, and that so much the greater, as it is nearer the Point of concurrence.

If a luminous Body be placed in the Centre of the Mirrour, all the Rays will be reflected back upon themselves.

Hence if the Eye be placed in the Centre of a Concave Mirrour, it will see nothing but itself, and that confusedly through the whole Mirrour.

If a Ray falling from the Point of the Cathetus *h*, Fig. 10. on the Convex Mirrour *h F*, be together with its reflex *j F*, continued within the Concavity of the Mirrour; *F H* will be the incident Ray from the Point of the Cathetus *H*, and *F O* its reflex.

Hence, since the Point of the Cathetus *H* is the Image of the Point *h* in the Convex Mirrour; but the Point *h* the Image of *H* in the Concave: if the Image of an Object reflected by a Convex Speculum, be seen by a Reflection made in its Concavity, it will appear like the Object itself. Since the Image of an infinite Cathetus is less in a Convex Glafs by one fourth of its Diameter; a Portion of the Cathetus less than a fourth part of the Diameter, may appear of any Magnitude required in a Concave one.

A Point therefore distant from a Concave Speculum, less than  $\frac{1}{4}$  of the Diameter must appear behind the Mirrour at any distance, how great soever.

Since the Image of any Object how broad soever, is contain'd in a Convex Speculum, between the two Lines of Incidence of its extrem Points; if an Object be placed between the two Lines at a distance less than  $\frac{1}{4}$  of its Diameter, the Breadth of the Image, how great soever may all appear.

Since then the Image of an Object included between two Lines, at a Distance less than one fourth of the Diameter, may exceed the just Height and Breadth of the Object; nay, may be made of any Magnitude, how big soever; Objects placed between the Focus and the Mirrour, must appear of enormous Magnitudes in Concave Mirrours; the Image being so much the greater in the Concave Mirrour, as it is less in the Convex.

In a Convex Mirrour, the Image of a remote Object appears nearer the Centre than that of a nearer Object: therefore in a Concave Mirrour, the Image of an Object remote from the Mirrour, appears at a greater Distance than that of a nearer Object, provided the Distance of the Object from the Centre be less than a fourth part of the Diameter.

In a Convex Speculum, the Image of a remote Object is less than that of a near one; therefore in a Concave one, the Image of an Object placed between the Focus and the Mirrour, is nearer the Focus than the Speculum. The Image therefore of an Object receding continually from a Concave Speculum, becomes continually greater, provided it don't recede beyond the Focus, where it becomes confused; and as it approaches, it grows continually less.

In a Convex Speculum, if the Sphere, whereof it is a Segment, be smaller, the Image is smaller than another of a larger Sphere; therefore in a Concave, if the Sphere whereof it is a Segment, be smaller, the Image will be larger than in another, whose Sphere is larger; whence Concave Mirrours, if they be Segments of very small Spheres, will do the Office of Microscopes.

If an Object be placed between a Concave Mirrour and its Focus, its Image will appear behind the Mirrour, in an erect but inverted Situation.

If



If an Object A B, Fig. 11. be placed between the Focus and the Centre, its Image E F will appear inverted, and in the open Air beyond the Centre, the Eye being placed beyond the Centre.

If an Object E F Fig. 11. be placed beyond the Centre C, and the Eye likewise beyond the Centre, the Image will appear inverted in the open Air between the Centre and the Focus.

Hence, the inverted Images of Objects placed beyond the Centre, are reflected by a Concave Mirrour, erect, and may be received on a Paper apply'd between the Centre and the Focus, especially if the Room be dark: if the Object E F be further distant from the Centre than is the Focus, the Image will be less than the Object.

On this Principle, Concave Mirrours, especially those which are Segments of large Spheres, and are capable of reflecting entire Objects, exhibit many pleasing Phænomena. Thus if a Man flourish a Sword against the Mirrour, another comes out thereof, and meets him with the same Motions; and the Image of his Head coming out of the Mirrour, if he strike it with his real Sword, the imaginary Sword will strike his real Head. If he stretch out his Hand, another Hand will be stretch'd out of the Mirrour, and meet it at a great Distance in the open Air, &c.

And on the same Principle are built Catoptric Cistulæ, which when look'd into, exhibit Images vastly bigger than the Chest.

The Image of a right Line perpendicular to a Concave Mirrour, is a right Line; but all oblique or parallel Lines are Concave.

Cylindrical, conical, parabolical, and elliptical Mirrours, or Specula, are those terminated by a Surface respectively cylindrical, conical, parabolical, and sphæroidical.

To prepare or make cylindrical, conical, parabolical, elliptical, and hyperbolical Mirrours.

For cylindrical and conical Mirrours, if they are to be of Glass, the Method of preparing them is the same as that already laid down for Convex Mirrours.

If of Metal, they are to be made after the Manner of Concave Mirrours, only that the Clay Moulds there described, require other Wooden ones of the Figure of the Mirrour.

For elliptical, parabolical, and hyperbolical Mirrours, the Mould is to be thus prepared. On a Wooden or Brazen Plane or Table, describe the Figure of an Ellipsis, A B, Fig. 12. a Parabola, or an Hyperbola C D, Fig. 13. after the Manner taught under those Heads; which done, cut out the Figure from the Plane with all the Accuracy imaginable.

To the Elliptic Figure, fit an Axis, as E F, with two Fulcra to sustain it, &c. and to move it. Lay a Quantity of the Lay above described under it; and turn about the Axis by the Handle, till the Plane A B have turned, or impress'd the Elliptical Figure exactly thereon.

The Axis of the parabolical, or hyperbolical Figure C D, is to be fixed at the Vertrex in such Manner as it may always remain erect. This is to be turn'd about as above, till it have given its own Figure to the Clay apply'd about it.

The part of the Mould thus form'd, is to be dry'd, and either smear'd over with Fat, or sprinkled with Brick-Dust. Then a Convex Mould to be made, by putting a Quantity of the same Clay into the Cavity thus form'd. This latter is call'd the Male, as the former the Female Mould.

The Male Mould being well dried, is to be apply'd within the Female; in such Manner as only to leave the intended Thickness of the Mirrour between them. The rest as for Concave Mirrours.

These Mirrours are not made without the utmost Difficulty; by reason, be the Moulds ever so just, the Figure of the Mirrour is apt to be damaged in the Grinding.

Phænomena, or Properties of cylindrical Mirrours.

The Dimensions of Objects corresponding length-wise to the Mirrour, are not much chang'd; but those corresponding breadth-wise, have their Figures alter'd, and their Dimensions lessen'd so much the more, as they are further from the Mirrour: Whence arises a very great Distortion.

If the Plane of Reflexion cut the cylindric Mirrour through the Axis, the Reflexion is perform'd in the same Manner, as in a plain Mirrour; if it cut it parallel to the Base, the Reflexion happens in the same Manner as in a spherical Mirrour; if, lastly, it cut it obliquely, or to be oblique to its Base, the Reflexion is the same as in an elliptic Mirrour.

Hence as the Plane of Reflexion never passes through the Axis of the Mirrours, except when the Eye and objective-Line are in the same Plane; nor parallel to the Base, except when the radiant Point and the Eye are at the same Height: The Reflexion in a cylindric Mirrour is usually the same as in an Elliptic one.

If a hollow cylindric Mirrour be oppos'd directly to the Sun, instead of a Focus of a Point, the Rays will be reflected into a lucid Line parallel to its Axis, at a distance somewhat less than a fourth part of its Diameter.

Hence arises a Method of drawing Anamorphoses, *i. e.* wild deformed Figures on a Plane, which appear beautiful and well proportioned when view'd in a cylindric Mirrour. For elliptic, parabolic, conic, and pyramidal Mirrours, we are not much acquainted with their Properties: Only that,

In the First, if a Ray strike on it from one of its Focus's it is reflected into the other: so that a lighted Candle being placed in one, its Light will be collected in the other.

That the Second, inasmuch as all the Rays they reflect meet in one Point, make the best Burning Glasses of all others.

And, Lastly, that wild irregular Figures may be so drawn on a Plane, as that the Eye being placed over the Axis of the two last, they shall appear beautiful and well proportioned.

MISADVENTURE, or *Misaventure*, in Law, has a special Signification, for the killing of a Man, partly by Negligence, and partly by Chance. As if a Man, thinking no Harm, carelessly throws a Stone, or shooteth an Arrow, &c. wherewith he killeth another: In this Case he commits not Felony, but only loseth his Goods, and hath Pardon of Course for his Life. Some between *Aventure* and *Misaventure* make this Distinction, That *Aventure* is meer Chance: As if a Man, being upon or near the Water, be taken with some sudden Sickness, and so falls in and is drown'd: or into the Fire, and be burn'd to Death. *Misaventure*, they say, is where a Man cometh to his Death by some untoward Violence; as the Fall of a Tree, the Running of a Cart-wheel, the Stroke of a Horse, or the like.



MISE, in Law, hath several Significations: As first, a Gift or Customary Present which the People of *Wales* give to every new King or Prince at their Entrance into that Principality. Sometimes *Mises* are taken for Taxes or Tollages, *Anno* 25. E. 1. 5. Sometimes for Costs and Expences; as *pro Misis & Custagiis*, for Costs and Charges ordinarily used in the Entries of Judgment in Personal Actions.

*Mise* is also a Term of Art, appropriated to a *Writ of Right*; so called, because both Parties have put themselves upon the meer Right, to be tried by the *Grand Assise*, or by *Battel*. So that which in all other Actions is called an *Issue*, in a *Writ of Right* is called a *Mise*; unless a Collateral Point be tried, and there it is called an *Issue*.

To join the *Mise* upon the *Meer*, signifies, to join the *Mise* upon the *Clear Right*; which is to join upon this Point, Whether hath more Right, the Tenant or Demandant?

MISERERE *Mei*, or *Chordapsus*, is a most vehement Pain in the Guts, proceeding from an Inflammation of them, or Involution, and the Peristaltick Motion inverted; whence the Excrements are discharged by the Mouth. It is called also *Volvulus*.

MISERICORDIA in Law, is used for an Arbitrary Amerciament imposed on any for an Offence; for where the Plaintiff or Defendant in any Action is amerced, the Entry is *Ideo in Misericordia*. It is called *Misericordia*, because it ought to be very moderate, and rather less than the Offence. Therefore if a Man be unreasonably amerced in a Court, not of Record, as in the *Court Baron*, &c, there is a *Writ* called *Moderata Misericordia*, directed to the Lord or his Bailiff, commanding them that they take moderate Amerciaments. Sometimes *Misericordia* is to be quit and discharged of all manner of Amerciaments, that a Man may fall into the Forest.

MISFEASANCE [in Law] Misdoings, Misdeeds or Trespases.

MISFEASOR [in Law] a Trespasser.

MISNOMMER, [of *mei*, amiss, and *nommer* [to Name] a Term in Law for a misnaming or misnaming; the using of one Name for another.

MISPRISION; a Term in Law, signifying Neglect or Oversight. As for Example:

*Misprision of Treason or Felony*, is a Neglect or light Account shewed of *Treason* or *Felony* committed, by not revealing it when we know it to be committed; or by letting any Person committed for *Treason* or *Felony*, or Suspicion of either, to go, before he be Indicted. *Misprision of Treason*, is the Concealment, or not disclosing of known *Treason*: For which, the Offenders are to suffer Imprisonment during the King's Pleasure; lose their Goods, and the Profits of their Lands, during their Lives. *Misprision of Felony*, is only Finable by the Justices before whom the Party is attainted: But Justices of the *Common-Pleas* have Power to assess Fines and Amerciaments upon Person offending by *Misprisions*, Contempts, or Neglects, for not doing, or misdoing any thing in or concerning Fines. *Misprision of Clerks*, is a Neglect of Clerks in writing, or keeping Records. By the *Misprision of Clerks*, no Process shall be annulled or discontinued: And Justices of *Assize* shall amend the Defaults of Clerks *misprising* of a Syllable, or Letter in writing.

MISSEN-Mast of a Ship is a round and long piece of Timber, standing in her Stern or sternmost Part. Some great Ships require two; then

the next the Main-mast, is the *Main-missen*; and that next the Poop, the *Bonaventure-missen*. But when at Sea, they use the Word *Missen* alone, they always mean the Sail, and not the Mast. And to the Sail these several Terms of Art following belong: *Set the Missen*; i. e. Set the *Missen-sail* right, as she ought to stand. *Change the Missen*; i. e. Bring the *Missen-yard* over to the other side of the Mast. *Peek the Missen*; i. e. Put the *Missen-yard* right up and down the Mast. *Spell the Missen*, i. e. Let go the Sheet; and withal, *Peek up the Yard*. The Use of this *Missen* is to keep a Ship close to a Wind: Wherefore, if a Ship be apt to *Gripe* too much (as they call it) they use no *Missen*. A *Missen* is made use of often when a Ship rides at Anchor, to back her a-Stern, so that she may not foul her Anchor on the turning of the Tide. Sometimes also they *Lie a-Try* with their *Missen* only. The Length of the *Missen* is the same with the Height of the Main-top-mast from the Quarter-deck, and the *Missen-top-mast* half that.

MISSES. See *Mise*.

MITE [with *Moniers*] a Weight equal to the 20th Part of a Grain, and is divided into 24 doits.

MITRALES, are two Valves at the Orifice of the *Vena pulmonaris*, in the Left Ventricle of the Heart; and are so called, because, when they are joined together, they something resemble a Mitre: They are broader than the other Valves; they are situated so as to look inwards, and do very little differ in Bigness and Form from the *Tricuspid* in the right Ventricle. Their Use is to hinder the Reflux of the Blood brought into the Left Ventricle of the Heart by the *Vena pulmonaris*, back towards the Lungs again.

MITRE, in Architecture, is the Workmens Term for an Angle that is just 45 Degrees, or half a right one; and if it be a Quarter of a Right Angle, they call it a *Half-Mitre*: And they have an Instrument made to this Angle which they call the *Mitre Square*, with which they strike Mitre Lines on their Quarters or Battens; and for Dispatch they have a *Mitre Box*, as they call it, which is made of two Pieces of Wood, each about an Inch thick, and one is nailed upright upon the Edge of the other; the upper Piece hath the Mitre Lines struck upon it on both Sides, and a Kerf to direct the Saw in cutting the Mitre Joints readily, by only applying the Piece into this Box.

MITRED Abbots, were formerly Governors of such Religious Houses, as had obtained from Rome the Privilege of wearing the Mitre, Ring, Crozier, and Gloves of a Bishop. It hath been a vulgar Error, that these *Mitred Abbots* were all the same with those *Conventual Prelates* who were summoned to Parliament as *Spiritual Lords*; but some of those summoned to Parliament were not *mitred*; and some that were *mitred* were not summoned; the Summons to Parliament not any way depending on their *Mitres*, but on their receiving their Temporals from the King. *Cowel's Interpreter*.

MITTA, was anciently a Saxon Measure containing 10 Bushels.

MITTELLA, is the Surgeons Term for the Swath that holds up the Arm when it is hurt or wounded.

MITTENDO *manuscriptum pedis finis*, is a *Writ Judicial*, directed to the Treasurer and Chamberlain of the *Exchequer*, to search and transmit the Foot of a Fine, acknowledged before Justices in Eyre, into the *Common-Pleas*, &c.



**MITTIMUS**, is a Writ by which Records are transferred from one Court to another, sometimes immediately: As out of the *King's-Bench* into the *Exchequer*; and sometimes by a *Certiorari*, into the *Chancery*; and from thence, by a *Mittimus* into another Court. This Word is also used for the Precept that is directed by a Justice of Peace to a Gaoler, for the receiving and safe-keeping a Felon, or other Offender by him committed to the Gaol.

**MIVA**, in Pharmacy, is the Flesh or Pulp of a Quince boiled up with Sugar into a thick Consistence.

**MIXT**, *i. e.* a *Mixt Body*: By which in Chymistry and Natural Philosophy, is understood a Body not mixt or compounded by Art, but by Nature; such as Minerals, Vegetables and Animals, from whom by Chymistry different Substances can be separated.

**MIXT Figures in Geometry.** See *Figures*.

**MIXT Number**, is one that is part Integer or whole Number, and part Fraction; as,  $4\frac{1}{2}$ ,  $10\frac{1}{2}$ , &c.

**MIXT Reason or Proportion**, is when the Sum of the Antecedent and Consequent is compared with the Difference between Antecedent and Consequent: As, if  $\begin{matrix} 3 & 4 & 12 & 16 \\ a & b & c & d \end{matrix}$  Then

$$\begin{matrix} 7 & 1 & 28 & 4 \\ a + b & a & b & c + d & c & d \end{matrix}$$

**MIXT Action** [in Law] is an Action of two different natures, being partly real and partly personal, or that lies both for the thing detained and against the Person of the detainer.

**MIXT Mode** [according to Mr. Lock] is a Combination of several simple Ideas of several Kinds.

**MIXT Tythes.** See *Tythes*.

**MOAT**, in Fortification, is a hollow Space or Ditch dug round a Town or Fortrefs which is to be defended; whereof the Length and Breadth often depends upon the Nature of the Soil, according as it is Marthy or Rocky. But *Moats* in general may be from 16 to 22 Fathom broad, and from 15 to 25 Foot deep.

**Dry Moat**, is that which is destitute of Water, and ought to be deeper than one that is full of Water.

**Lined Moat**, is that whose Scarp and Counter-scarp are cas'd with a Wall of Masons-Work lying in *Talus* or a-sloap.

**Flat-bottom'd Moat**, is that which hath no sloaping, its Corners being somewhat rounded. All Moats must be well flanked, and in general so wide, as that no Ladder, Tree, &c. can reach across it. If the Ditch be dry, or has but little Water, there is usually another small Trench cut quite along the middle of it.

**MOAT**, the Brink of the Moat next the Rampart in any Fortification, is called the *Scarp*, and the opposite one the *Counter-scarp*.

**MODEL**; is an Original Pattern which any Workman proposes to imitate; 'tis variously made of Wood, Stone, Plaster, &c. and should be (in Architecture, for Instance) made by a *Scale*, where an Inch or half an Inch represents a Foot, for the more exact completing of the Design.

**MODEL in Architecture.** See *Module*.

**MODERATA Misericordia**, is a Writ for him that is amerced in a *Court Baron*, or other being not of Record, for any Transgression or Offence beyond the Quality of a Fault. It is directed to the Lord of the Court, or his Bayliff, command-

ing them to take a *moderate Amerciament* of the Party, and is founded upon *Magna Charta*, cap. 14. *Quod nullus liber homo amercietur nisi secundum qualitatem delicti*, &c.

**MODERN** [in *Architecture*] is applied to the present or *Italian Manner* of Building; but this improperly, as being according to the Rules of the Antique; but in strictness it is only applicable to that which partakes partly of the Antique, retaining something of its Delicacy and Solidity, and partly of the *Gothick*, whence it borrows Members and Ornaments, without Proportion or Judgment.

**MODES in Musick.** See *Mood*.

**MODIFICATION** [in *Philosophy*] the modifying of a Thing, or the giving it this or that Manner of being.

**MODILLONS**, or *Modillions*, in Architecture, are little Brackets which are often set under the Cornices, more-especially in the *Corinthian* and *Composit* Order, and serve to support the Projection of the *Larmier* or *Drip*. The Word comes from the Italian *Modiglione*, signifying a little Model or Measure; but this Part must be distinguished from the great Model, which is the Diameter of the Pillar: For as the Proportion of an Edifice in general depends on the Diameter of the Pillar, so the Size and Number of the *Modillions*, as also the Interval between them ought to have due Relation to the whole Fabrick.

**MODIOLUS**, *Trepanum*, or *Anabaptiston*, is an Instrument which they use in profound Corruptions, Contusions, Cuts, and Fractures of the Bones of the Head, not to be applied; unless, 1. The Chips and Prominences of the Bones prick. 2. When the upper Table is entire, but depress'd; and the Lower broken. 3. When the extravasated Blood would choak a Man with Corruption. The manner of *Trepanning*, or opening the Skull is thus: When the Hairs are shaven off, the Skin is to be cut to the *Pericranium*, avoiding, as carefully as may be, the Muscles of the Temples, and the Sutures of the Skull; and for this time the Wound is to be bound up, unless there be so little Blood spilt, that the Membrane, called *Pericranium*, may at the same time be pulled off from the Skull. Then after a few Hours you may stop the Ears of the Patient, take one of these Instruments, called a *Masculine Modiolus*, whose Point is to be fixed in the Skull, but so far off the Fracture, that it touch it not, much less the Suture, with its Teeth; tho' some Surgeons never avoid the Sutures, and assure us that they have perforated them as successfully as any other Part: Then hold the Instrument fast with the Left Hand, and turn it round with the Right, 'till you have cut a pretty deep Hole: After this take a *Feminine Modiolus*, (which has no Point in the middle) and turn it round, as before. In the mean time take away the Dust or Chips that proceed from the Perforation, and moisten the Instrument in Oyl and Water, to make it cool and slippery. The Blood that appears, will shew that you are now gone as deep as the second Table, *i. e.* beyond the Skull, to the *Meninges*; and then you must press very gently, lest the Membrane of the Brain be unadvisedly hurt. When the Bone begins to wag, put something in betwixt the sides of the Wound; loosen it, and take it out with a pair of Surgeon's Pincers. *Blanchard*.

**MODO & Forma**, are Words of Art in Process and Pleadings; and namely, in the Answer of the Defendant; whereby he denieth himself to have done the Thing laid to his Charge. *Modo & forma declarata*: It signifies as much as that Clause



in the Civil Law, *negat allegata prout allegantur, esse vera*; where *modo & forma* are of the Substance of the Issue, and were but Words of course.

MODULE, or *Model*, in Architecture, is a certain Measure invented by *Vignola*, and made use of to regulate the Proportion of the whole Building. It is generally half the Diameter of a Pillar at the lower end, in the *Tuscan* and in the *Doric* Order; but in others, the whole Diameter. This Diameter is divided into 12 equal Parts; and into 18 for the *Ionick*, *Corinthian*, and *Composit* Orders. And this *Module* or *Model* is a kind of Universal Measure, which helps us to get rid of the great Uncertainties there are in the Feet and Inches of divers Nations, and at divers Times.

MODUS *Decimandi*, is when either Land, a Sum of Money, or Yearly Pension, is given to the Parson, &c. by Composition, as Satisfaction for his Tythes in kind.

MOINEAU, is a Name the *French*, and some Modern Writers of Fortification, give to a little *Plat-Bastion*, which is raised before a Curtain that is too long, and which hath two other Bastions at the ends of it; for they being out of Musket-shot one of the other, must be defended by some such thing as this *Moineau* or *Plat-Bastion*. Sometimes the *Moineau* joins to the Curtain, and sometimes is disjointed from it by a Moat.

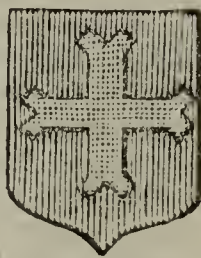
MOLA *Genu*, *Patella*, or *Rotula*, is a round and broad Bone, placed at the jointing of the Thigh and Leg, to preserve the Knee from slipping out, and to defend the Juncture from External Injuries.

MOLA *Carnea*, is a Fleshy and sometimes a Spongy Substance, without Bones or Bowels: It is often black, like concremented Blood; and sometimes extream hard; preternaturally brought into the World instead of a *Fœtus*.

MOLARES, or *Maxillares Dentes*. See *Dentes*.

MOLECOLA [in *Physicks*] a little Mass or part of any thing.

MOLINE. The Heralds Term for one of their Crosses of this Figure. The *Field Azure*, a *Cross Moline*, or, by the Name of *Molineaux*. *Guillim* saith this Cross representeth a Mill-Rind, or the Form of the Ink of a Mill.



MOLMUTAN or *Molmutin Laws*, were the Laws of *Dunwallo Molmutius*, sixteenth King of the *Britains*; they were famous here till the Time of *William* the Conqueror. *Molmutius* was the first that published Laws in *Britain*; and these Laws, with those of Queen *Mercia*, are published in Latin by *Gildas*, out of the *British* Tongue.

MOLOSSUS, is the Foot of a Latin Verse, consisting of three Syllables, when they are all long.

MOMENTS, are sometimes taken for the least and most insensible Parts of Time; as when we say, such a thing was done in a Moment.

In Mathematicks, *Moments* are such indeterminate and instable Parts of Quantity, as are supposed to be in perpetual Flux, *i. e.* either continually decreasing or increasing; which latter are taken for Affirmative and Positive Moments, and the former for Negative or Subtractible ones; And these continually increasing or decreasing Particles are supposed to be infinitely small; for as soon as

ever they come to be of any finite Magnitude, they cease to be *Moments*. *Moments* therefore are to be look'd upon as the generative Principles of finite Magnitudes; and are here supposed to have no Magnitude, but to be *Inceptive* only of it, to use Dr. *Wallis* his Word.

And because 'tis the same thing, if in the room of these Moments, the Velocities of their Increases or Decreases be made use of, or the finite Quantities proportionable to such Velocities; this Method of proceeding, which considers the Motions, Changings, or Fluxions of Quantities, hath come to be called *Fluxions*.

*Moments* also in a Physical Sense, as they are used in reference to the Laws of Motion, signifie the *Quantities of Motion* in any moving Bodies; and sometimes, simply, the Motion it self; and they define it to be the *Vis insita*, or *Power* by which any moving Bodies do continually change their Places.

And in comparing the Motions of Bodies, the *Ratio* of these Moments is always compounded of the Quantity of Matter in, and the Celerity of the moving Body: So that the *Moment* of any moving Body may be considered as a *Rectangle under the Quantity of Matter into the Celerity*. And since 'tis certain that all equal Rectangles have their Sides reciprocally proportionable, (14. *è. 6. Eucl.*) therefore if the *Moments* of any Moveables are equal, the Quantity of Matter in one, to that of the other, will be reciprocally :: as the Celerity of the Latter to the Celerity of the Former: And *vice versa*, if the Quantities of Matter are reciprocally proportionable to the Celerities, the *Moments* or Quantities of Motion in each will be equal.

The *Moment* of any moving Body may be considered also as the Aggregate or Sum of all the Moments of the Parts of that Body; and therefore where the Magnitudes and Number of any Particles are the same, and where they are moved with the same Celerity, there will be the same *Moments* of the Wholes.

MONADES. See *Digits*.

MONETAGIUM [old *Rec*] the Right or Privilege of Coining Money.

MONIERS. See *Mint*.

MONKS-Seam. So the Sailors call sewing the Edges or Selvages of the Sails together, one over another; and 'tis sew'd on both sides, to make it the stronger.

MONOCHORD, [*μονόχορδον* Gr.] a kind of Instrument anciently of singular Use for the Regulating of Sounds; but some appropriate the Name of *Monochord* to an Instrument that hath only one single String, as the *Trumpet Marine*.

The Ancients made use of the *Monochord* to determine the Proportion of Sounds to one another: When the *Chord* was divided into two equal Parts, so that the Terms were as 1 and 1, they call them *Unisons*; but if they were as 2 to 1, they called them *Octaves* or *Diapasons*; when they were as 3 to 2, they called them *Fifths*, or *Diapentes*; if they were as 4 to 3, they called them *Fourths*, or *Diatesserons*; if the Terms were as 5 to 4, they call it *Diton*, or a *Tierce major*; but if the Terms were as 6 to 5, then they call it a *Demi-diton*, or a *Tierce Minor*; and lastly, if the Terms were as 24 to 25, they called it a *Demiton* or *Dieze*.

The *Monochord* being thus divided, was properly that which they called a *System*, of which there were many kinds, according to the different Divisions of the *Monochord*.



**MONOCOLUM**, [*μονόκαλος* Gr.] is the Gut *Cæcum*.

**MONOGRAM** [*Μονογράμμιον* of *μόνος* and *γράμμα* Gr. a Letter] a Cypher or Character compos'd of one or more Letters interwoven; being a kind of Abbreviation of a Name, used in Seals, Coats of Arms, &c.

**MONOME**, [in *Algebra*] a Quantity that has but one Denomination or Name, as a b, a a b, a a a b.

**MONOPETALOUS** *Flowers* [of *μόνος* single and *πέταλον* Gr. a Flower-Leaf,] (in Botany) are such, as, though they may be seemingly cut into four or five small *Petala* or Leaves, are yet all of one piece, and which falling off all together, have their Flower in one piece. See *Petala*.

**MONOPOLIZERS**, are such Persons as combine together to engross, and to raise the Price of Goods.

**MONOPOLY**, [*μονοπώλιον* Gr.] in Law, is a Grant to any Person or Persons, of or for the sole buying, selling, making, working, or using any Commodity.

**MONOPTOTE** [*μονόπτοτον* of *μονο* and *πῶσις* Gr. a Case] a Noun which has only one Case.

**MONOPYRENOUS**, *Fruits* [of *μονο* and *πυρήν* Gr. a Kernel] such Fruits as contain no more than one Kernel and Seed.

**MONOSYLLABLE** [in *Grammar*] a Word consisting but of one Syllable, or of one or more Letters pronounced all together.

**MONOTRIGLYPH**, [*μονοτρέγλυφον* Gr.] a Term in Architecture, signifying the Space of one *Triglyph* between two *Pilasters*, or two *Columns*.

**MONSOONS**, are shifting Trade Winds in the E. *Indian Ocean*, which blow periodically, some for half a Year one way, others but for 3 Months, and then shift and blow for 6 or 3 Months directly contrary.

**MONSTRANS**, *De droit*, in a Legal Sense, signifies a Suit in *Chancery*, for the Subject to be restored to Lands and Tenements, which he shews to be his Right, tho' by Office found to be in the Possession of another lately dead; by which Office the King is entituled to a Chattel, Free-hold, or Inheritance in the said Lands.

**MONSTRANS** *De faits ou Records*, shewing of *Deeds or Records*, is thus: Upon an Action of Debt brought upon an Obligation, after the Plaintiff hath declared he ought to shew his Obligation; and so it is of *Records*. And the Difference between *Monstrans de faits* and *Oyer de faits*, is this: He that pleads the *Deed or Records*, or declares upon it, ought to shew the same; and the other, against whom such *Deed or Record* is pleaded, may demand *Oyer* of the same.

**MONSTRAVERUNT**, is a Writ that lies for the Tenants in *Ancient Demesne*, being distrained for the Payment of any Toll or Imposition, contrary to their Liberty which they do or should enjoy.

**MONTPAGNEL** or *Pagnote*, or the *Post of the Invulnerable*, is an Eminence chosen out of Cannon-shot of a Place besieged; where curious and wary Persons place themselves to see the Attack and the manner of the Siege.

**MONTH**, properly speaking, is the Time in which the Moon runs through the Zodiack, and therefore is accounted by the Motion of the Moon; and therefore the Lunar Month is either *Periodical*, which is the Time of the Moon's Motion from

any one Point of the Zodiack to the same again, and is something less than 27 Days and 8 Hours; or else *Synodical*, which is the Time between New Moon and New Moon, and is something more than 29 Days and an half.

There is also a *Solar Month*, which is the Time that the Sun takes up in running through one of the Signs of the Zodiack, and is almost 30 Days and half.

And both these *Solar* and *Lunar Months* are either *Astronomical*, like those above-mentioned; or *Civil*, which are various, according to the Usage of accounting in different Places, Cities and Nations.

The *Egyptians* accounted by *Solar Months*, each of 30 Days; and to compleat their Year, after 12 such Months, they added 5 Days, which the odd Hours made up.

But most of the Ancient Nations accounted by the *Lunar Synodical Month*; as the *Jews*, *Greeks*, and the *Romans*, 'till *J. Caesar's* Time; and as the *Mahometans* do to this Day. And because these Months did not contain an exact Number of Days, to adapt them to *Civil* Computation, they accounted alternately one Month to have 30, and the next 31 Days; and by this means they made two such *Civil* Months to be equal to two *Lunar* ones of 29 Days and half; and they brought it to pass, that the New Month, for a Run of many Years, did not much deviate from the First Day of the *Civil* Month.

**Philosophical MONTH**, [in *Chymistry*] is the Space of 40 Days and Nights.

**MOODS** in *Grammar*, determine the Signification of *Verbs*, as to the Manner and Circumstances of the Affirmation; and are in Number Six, viz. The *Indicative*, the *Imperative*, the *Optative*, the *Potential*, the *Subjunctive*, and the *Infinitive Mood*; which see.

**MOOD** in *Musick*, signifies certain Proportions of the Time, or Measure of Notes. These *Moods* or *Modes* of measuring Notes, were formerly Four in Number, viz.

1. *The Perfect of the More*, in which a *Large* contain'd three *Longs*, a *Long* three *Breves*, a *Breve* three *Semi-breves*, and a *Semi-breve* three *Minims*.

2. *The Perfect of the Less*, wherein a *Large* comprehended two *Longs*, a *Long* two *Breves*, a *Breve* three *Semi-breves*, and a *Semi-breve* two *Minims*.

3. *The Imperfect of the More*, in which a *Large* contained two *Longs*, a *Long* two *Breves*, a *Breve* two *Semi-breves*, and a *Semi-breve* three *Minims*.

4. *The Imperfect of the Less*, is the same with that which we call the *Common Mood*, the other three being now altogether out of Use; although the Measure of our *Common Triple-time* is the same with the *Mood Imperfect of the More*, except that we reckon but two *Minims* to a *Semi-breve*, which in that *Mood* comprehends three.

In our *Common Mood*, two *Longs* make one *Large*, two *Breves* a *Long*, two *Semi-breves* a *Breve*, &c. proceeding in the same Order to the last or shortest Note: So that a *Large* contains two *Longs*, four *Breves*, eight *Semi-breves*, sixteen *Minims*, thirty two *Crotchets*, sixty four *Quavers*, &c. Besides



Besides these *Moods of Time*, Five others relating to Tune, were in Use among the Ancient *Grecians*, which were termed *Tones* or *Tunes* by the *Latins*; the Design of either being to shew in what Key a Song was set, and how the different Keys had relation one to another.

These sorts of *Moods* were distinguish'd by the Names of the several Provinces of *Greece*, where they were first invented; as the *Dorick*, *Lydian*, *Ionick*, *Phrygian*, and *Æolick*.

*Dorick Mood* consisted of slow tun'd Notes, and was proper for the exciting Persons to Sobriety and Piety.

*Lydian Mood* was likewise used in Solemn Grave Musick; and the Descant or Composition was of slow Time, adapted to Sacred Hymns or Anthems.

*Ionick Mood* was for more light and soft Musick; such as pleasant amorous Songs, Sarabands, Corants, Jiggs, &c.

*Phrygian Mood* was a Warlike kind of Musick, fit for Trumpets, Hautboys, and other Instruments of the like Nature; whereby the Minds of Men were animated to undertake Military Atchievements, or Martial Exercises.

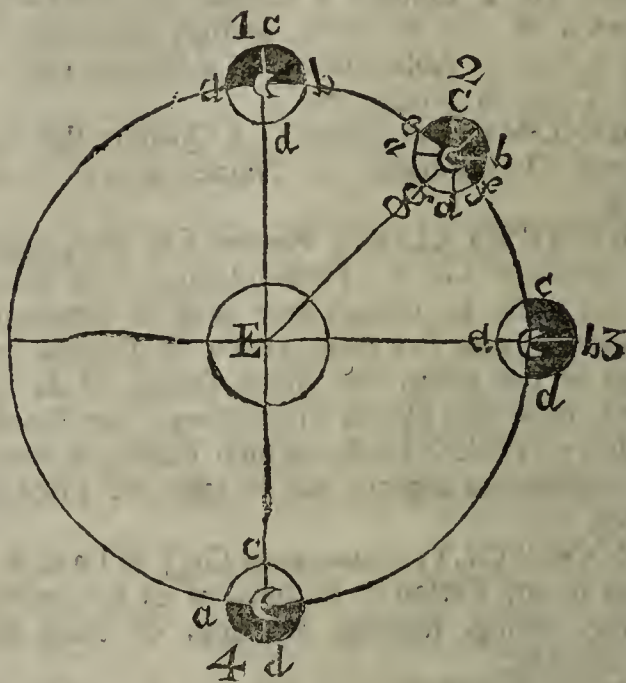
*Æolick Mood*, being of a more airy, soft, and delightful Sound, such as our *Madrigals*, served to allay the Passions by the means of its grateful Variety and melodious Harmony.

These *Moods* or *Tones* were distinguished into *Authentick* and *Playal*, with respect to the dividing of the *Octave* into its Fifth and Fourth: The Former was when the Fifth possessed the Lower Place, according to the Harmonical Division of an *Octave*; and the other was when it stood in the Upper Place, according to the Arithmetical Division of the same *Octave*.

MOON. The Reason why the ☾ always shews the same Face towards us, is because she revolves round her Axis in the Time of her Periodical Month.

For if in moving in her Orbit round the Earth she did not do so, but that the Horizon of the Disk *ab* kept always parallel to it self in all Positions, 'tis plain, that as the Moon moves on in her Orbit, new Parts of the former dark Hemisphere will begin to be enlightned (or rendred visible to us;) as appears plain from the Figure annexed. For suppose the Moon to have moved in her Orbit from 1 to 2, and that her Diameter *ab* keeps parallel to its self in its first Situation; then her visible Hemisphere will be, not as before *adb*, but *egf*: and when she comes into Position 3, her visible Hemisphere will be *cad*, instead of *adb*, as at first: And lastly, when the Moon is at 4, her visible Hemisphere will be *acb*, which in the first Position was totally invisible. And this can't be otherwise, if the Moon in her Revolution round the Earth, don't also revolve round her own Axis in the same exact Space of Time: But if you suppose her so to turn round her Axis, that the Diameter *ab* shall always be in a Normal Position to the Line E ☾; as in the 2d and 3d Positions *ef* and *cd* are; 'tis plain the Moon must by such a Motion round her Axis, always shew the same

Face to you, as in Fact (abstracting from her Vibrations, &c.) she really doth.



The annual Regression of the Moon's Nodes is 25 Degrees, and the Nutation of her Orbit about 20 Minutes.

The Phænomena of the Moon, on which, as Foundations, the Lunar Astronomy is built, are such as these.

1. That the Moon moves daily from *West* to *East*, and almost in the same Line with the Earth, or nearly in the *Ecliptick*.

For all the Secondary Planets describe lesser Orbits round their Primary, as they do round the Sun; and the Planes of their Orbits are not very different from that of the *Ecliptick*, and these Secondary Planets, do also move the same Way as the Primary ones.

2. But yet the Moon doth not move accurately in the same Plane of the *Ecliptick*, deviating sometimes a little to the *North*, and sometimes to the *South*; as is apparent from her Meridian Altitudes. The Plane of her Orbit being inclined to that of the *Ecliptick*, and intersecting it in two Points, which are called the Moon's *Nodes*.

3. The Phases of the Moon are continually changing; sometimes she cannot be seen at all, then she appears horned, bisected, gibbous, and at last round or full: And so on again in an inverse Order.

For being a spherical opaque Body, and receiving all her Light from the Sun: though he will always illuminate one Hemisphere of her, yet in the New-moon, when that Hemisphere is entirely turned from you, and her Body between the Sun and the Eye, 'tis impossible for her to appear visible: But as soon as by her Motion forward in her Orbit, Part of that Hemisphere comes to be obverted to the Earth, she will begin to appear *falcated* or with Horns of Light, and when she is got to be 90 degr. from the Sun, she will shew just one half of her illuminated Hemisphere, &c.

4. The Eclipse of the Sun happens only at the New-moon, though not at every one; and that of the Moon only when she is at the Full, though not at every Full-moon; as is plain from the Reason and Nature of Eclipses.



5. That obscure Part of the Moon's Body which the Sun's Rays do not illuminate, when she is Horned or Gibbous, or even in a Solar Eclipse, is not totally invisible, but appears with a reddish dirty coloured Light; and that Light seems to come to the Moon by Reflection from the Earth.

For when the Moon is at New to us, the Earth is at Full to the Lunar Inhabitants; and the Light of the Earth being about 15 times greater than that of the Moon, and the Moon so little as not to obscure above a 20th Part of the Earth, the Light from the Earth may easily be supposed to render her a little visible in even solar Eclipses.

6. The Eclipses of the Sun and Moon don't happen always in the *same* Places in the Zodiac, but in *others* moving still gradually backward, or in *Antecedentia*.

The Reason of which is, that the Moon's Orbit is different from that of the Ecliptick, intersecting it but in one Line, whose extreme Points are called the *Nodes*; and which *Nodes* do annually move backward or in *Antecedentia*: But the Eclipses cannot happen but when the two Luminaries are in or near these *Nodes*; wherefore, &c.

7. There is a very sensible Difference in the apparent Length of the Moon's Diameter, at different Times.

For the Moon's Orbit being Elliptical, her Distance from the Earth will be very different, as she is in different Parts of that Ellipsis; and 'tis found that her apparent Diameter is nearly reciprocally proportional to her Distance, which Distance is both *greatest* and *least* in the Syzygies, because the Excentricity of the Ellipsis is there greatest.

8. The apparent Motion of the Moon is not always equal, but greater and less by Turns, and that very sensibly.

Which Phænomenon arises from several Causes concurring together. The first Cause of which is some Inequality even in the mean Motions of the Moon; for in the Earth's *Perihelia* the Moon is carried something slower than in the *Aphelia*.

The next Cause is the Elliptick Figure of the Lunar Orbit, from whence the Moon must move faster in her *Perigæum* than in her *Apogæum*; as is the Case of all the Planets.

A 3d Cause is the continual changing of the Excentricity of the Moon's Orbit; from whence must arise a greater Difference of her Velocity in her *Perigæa*, and of her Tardity in her *Apogæa* in the Syzygies of the *Apsēs* than in the Quadratures.

To all which we may add, that the Moon's Motion it self is a little retarded from the Syzygies to the Quadratures, and then accelerated a little again from thence to the Syzygies, in every Lunar Month.

9. The monthly Motion of the Moon in the Ecliptick is swiftest (*ceteris paribus*) when she is in the Syzygies, and slowest when she is in her Quadratures to the Sun.

The Reason of which is to be had, not from any System of Astronomy, but from the Physical Principles of the *Newtonian* Philosophy.

10. That Place where the Moon appears least, and where her Motion is slowest, doth not keep

always in the same Degree of the Ecliptick, but moves sensibly forward, or in *Consequentia*.

For tho' her *Apogæum* go forward in the Syzygies, and backward in the Quadratures, yet because the former Motion is near twice as swift as the latter, the Excess in the whole Revolution of the *Apsēs* must be forward, and consequently the *Apogæum* will move on in *Consequentia*, as by Observation 'tis found it really doth.

11. The Latitude of the Moon is moveable or changeable, being sometimes greater and sometimes lesser (according to the various Position of her Orbit to the Sun) even in the same Degree of proper Longitude.

This Difference of Latitude arises from the various Inclination of the Plane of the Moon's Orbit to that of the Ecliptick. For, as was said above, there is an Inequality even in that Inclination; when the Line of the Nodes is in the Syzygies, the Angle of the Inclination is greatest, and least when that Line is in the Quadratures, and of a mean Quantity in the intermediate Positions.

12. The Moon's Orbit is more or less circular according to its various Position in respect of the Sun.

And so it must be, since as was shewn above, the Excentricity of her Orbit is greater when the Line of the *Apsēs* is in the Syzygies, than when it is in the Quadratures, by almost half the least Excentricity.

13. The Motion of the Moon is very unequal, and dissimilar to its self, whether you consider it in different Parts of the same Month, or in the similar Parts of different Months.

Nor is this strange, if you consider the various and dissimilar Mutations above-mentioned.

14. The Light of the Moon reflected to us is so weak, that even in the Full-moon, it will by no Burning-Glasses be brought to afford the least Degree of Heat.

The Rays of Light have their Force decreased, (at least) as the Square of their Distance; and consequently the Force of the Sun's Rays reflected to us from the Moon, to those that come to us directly, is decreased, at least in the Proportion of the Square of the Moon's Distance from the Earth, to the Square of the Moon's Semi-diameter; and by Calculation it will be found, that the Light of the Moon brought hither, will be in Force but the fifty thousandth Part of that which comes hither directly from the Sun.

15. The same Face of the Moon nearly, is always turned towards the Earth.

The Reason of which is, that she turns round her own Axis, in the Time of her menstrual Motion round the Earth, as I have demonstrated above.

16. And yet there are some Librations of this Face, so that some more Eastern and Western Parts of it, and sometimes some more Northern and Southern do alternately appear.

The Reason and Cause of which libratory Motion, Sir *Is. Newton*, I think, first discovered or communicated.

Dr. *Hook*, *Op. Post.* p. 80, 81. accounting for the Reason why the Moon's Light affords no visible Heat



Heat, faith, that the Quantity of Light which falls on the Hemisphere of the Full-moon, is rarified into a Sphere about 288 times greater in Diameter than the ☾ before it arrive to us; and consequently, that the Moon's Light is 104368 weaker than the Light of the Sun: Wherefore it would require 104368 Full-moons to give a Light equal to that of the Sun at Noon.

1. To find the Moon's Age.

To the Day of the Month (at any Time) add the *Epaet* (see that Word) for that Year, and the Months from *March* (including both Months) together, the Sum, if under 30, is the Moon's Age, if above 30. subtract thirty out of it, the Remainder is the Age of the Moon.

N. B. If the Month have but 30 Days, you must subtract but 29 instead of 30.

Example, May 26, 1708.

Epaet	18
Days in May	26
Months from March	3
—	—
	47
Deduct —	30
—	—

The Moon's Age 17 Days:

If the Time proposed had been between *Jan. 1.* and *March* the first, you must have used the *Epaet* for the Year before.

2. To find the Moon's being upon the Meridian or Southing.

Multiply her Age by 4, and divide the Product by 5, the Quotient will give the Hours, and the Remainder multiplied by 12 will give the *Minutes*, when the Moon is less than 15 Days old; but when more than that, you must subduct 15, and work with the Remainder, as before.

Example, May 26, 1708.

Moon's Age 17 Days.
Deduct 15
—
2
Multiply by 4
—
Divide by 5) 8 (1 hour, 36 m.
5
—
3
Multiply by 12
—
36 Minutes.

3. To find the Time of the Moon's Shining.

Multiply her Age by 48, and divide the Product by 60; the Quotient shall be the Hours, and the Remainder the Minutes: That is, if the Moon be under 15 Days old; but if above, subtract the Time of her Shining, found as above, from 24 Hours; the Remainder will be the Time of her Shining in the Morning.

Example, May 26, 1708.

Moon's Age 17 Days
48
—
136
68
—
60) 816 (13 h. 36 m.
60
—
From 24 Hours
Subtract 13 h. 36 m.
—
Remains the } 216
Time of her } 10 h. 24 m.
Shining. } —
—
36

4. To find how many Signs and Degrees the Moon is departed from the Sun since her last Conjunction with him, or since the last New-moon.

Double the Moon's Age, and divide the Product by 5, the Quotient is the Signs, and the Remainder (multiplied by 6) are the Degrees.

Example, May 26, 1708.

The Moon's Age 17 Days.
2
—
5) 34 (6 Signs.
30
—
Remains 4
Multiply by 6
—

Therefore the Moon is gone from 24 Degrees. the Sun 6 Signs, and 24 Degrees.

MOON. The Periodical Revolution of the Moon, in reference to the Fixed Stars, is 27 Days, 7 Hours, 43 Minutes: And in the same Space of Time, by a strange Correspondence and Harmony of the two Motions, it revolves the same way about its own Axis; whereby (one Motion as much converting it to, as the other turns it from the Earth) the same side is always exposed to our Sight.

The Librations of the Moon's Body, which occasion that the same Hemisphere exactly is not always exposed to our Sight, arise from the Eccentricity of the Moon's Orbit, from the Perturbations by the Sun's Attraction, and from the Obliquity of the Axis of the Diurnal Rotation of the Moon's own Orbit; without the Knowledge of which Circumstances, her *Phænomena* were inexplicable, but by the Consideration of them are very demonstrable.

The mean Horary Motion of the Moon, in respect of the Fixed Stars, is 32 minutes, 56 seconds, 27 thirds, 12 fourths and an half.

The Moon is distant from the Earth, according to most Astronomers, 59; according to *Vindeline*, 60; *Copernicus*,  $60\frac{1}{2}$ ; *Kircher*,  $62\frac{1}{2}$ ; and according to *Tycho*,  $56\frac{1}{4}$  Semidiameters of the Earth. Sir *Isaac Newton* thinks the Distance ought to be esteemed about 61: Therefore the mean Distance may be reckoned 60. But if the Earth and Moon move both round the Sun, with their common Centre of Gravity, that admirable Astronomer demonstrates, that the Distance between the Centres of the Earth and Moon, will be  $60\frac{1}{2}$  of the Earth's Semidiameter, *Prop. 60. Lib. 1. Princip.*



She is nearer the Earth at her *Syzygy*, than in the Quadrature, by  $\frac{1}{12}$  Part of the Distance.

According to M. *Cassini*, the Moon's greatest Distance from the Earth is 61, the mean Distance 56, and the least Distance 52 Semi-diameters of the Earth.

The Power of the Moon's Influence as to the Tides, is to that of the Sun as  $6\frac{1}{2}$  to one. Sir *Isaac Newton*.

As to the Inequality of the Moon's Motion, (which proceeds from the Action of the Sun, disturbing the Motion of the Secondary Planets) she moves swifter, and describes (by a Radius drawn from it to the Earth) a greater Area in proportion to the Time, hath an Orbit less curved, and by that means comes nearer to the Earth in her *Syzygies* or Conjunctions, than in the Quadratures, unless the Motion of her Eccentricity hinder it: Which Eccentricity is greatest, when the Apogee of the Moon happens in the Conjunctions; and is least, when the Apogee happens at the Quadratures. And therefore the Moon is swifter as well as nearer to us in her Perigee, and more remote and slower in her Apogee at the Conjunctions, than at the Quadratures; and her Motion is swifter also in the Earth's Aphelion, than in its Perihelion. The Apogee also goes forward swifter in the Conjunctions, and goes slower at the Quadratures: But her Nodes are at rest in the Conjunctions, and do recede most swiftly in the Quadratures.

The Moon also perpetually changes the Figure of her Orbit, or the Species of the Ellipse she moves in.

There are also some other Inequalities in the Motions of this Planet, which can hardly be reduced to any certain Rule: As, That the Velocities or Horary Motions of the Apogee and Nodes, and their Equations, and the Difference between the greatest Eccentricity in the Conjunctions, and the least in the Quadratures; and that Inequality which is called the *Variation of the Moon*: All these do increase and decrease annually, in a triplicate Ratio of the apparent Diameter of the Sun: And this *Variation* is increased and diminished in a duplicate Ratio of the Time between the Quadratures; as Sir *Isaac Newton* proves in many places of his *Principia*.

That Curious Person found the Apogee in the Moon's *Syzygies* to go forward 23 min. each Day in respect of the Fixed Stars; and to go backward 16 min.  $\frac{1}{2}$  each Day in the Quadratures: And therefore the middle Annual Motions he estimates at 40 deg.

This differs something from Mr. *Flamsteed's* Astronomical Tables; where the Diurnal Progression of the Moon's Apogee is 24 min. 28 seconds in the *Syzyges*, and the Recession 20 min. 12 seconds in the Quadratures. See the Words *Secondary Planets*.

That the Cause of the *Secondary Light of the Moon*, as they call it; that is, the obscure Part of her, appearing like kindled Ashes, just before and after the Change or New Moon, is the Sun's Rays reflected from the bright Hemisphere of the Earth to those dark Parts of the Moon, and thence again reflected to the Earth destitute of the Sun's Light; see proved in *Zucchi's Philosoph. Optic. Nov.* from p. 247, to p. 260. And also in *Tacquet's Opera Geometrica*.

The Excellent Sir *Isaac Newton* makes it a Proposition to enquire into the Figure of the Moon; and supposing it, as its first Original, to have been

a Fluid, like to our Sea, he calculates, that the Attraction of our Earth would raise the Water there to near 90 Foot high, as the Attraction of the Moon raiseth our Water to 12 Foot: Whence the Figure of the Moon must be a *Spheroid*, whose greatest Diameter extended, will pass through the Centre of our Earth; and will be longer than the other Diameter perpendicular to it, by 180 Feet. And from hence it comes to pass, that we see always the same Face of the Moon: For she cannot rest in any other Position, but will continually endeavour to conform her self to this Situation *Prop. 38. Lib. 3.*

The Moon hath properly no Atmosphere, such as our Earth hath, abounding with Clouds, Winds, Thunder or Lightning; because her Face always, when our Air is clear, appears distinct and clear; and by our Telescopes we can see the Sun's Light pass regularly and uniformly from one mountainous Place to another.

Mr. *Flamsteed* in *Philosoph. Transact.* N. 154. saith, That the best Tables of the Moon's Motions do err 12 minutes, or more, in her apparent Place; which causes a Fault of Half an Hour, or  $7\frac{1}{2}$  Degrees of the Longitude of Places endeavoured to be found out by her.

Mr. *Azout* says, That this Planet's Diameter never appear'd to him above 33 min. and never less than 24 min. 45 seconds.

Sir *Isaac Newton* reckons the mean Diameter of the Moon to be 32 minutes, 12 seconds, as the Sun's is 31 minutes, 27 seconds.

The Density of the Moon he concludes to be to that of the Earth, as 9 to 5 nearly: And that the Mass or Quantity of Matter in the Moon to that of the Earth, is as 1 to 26 nearly.

The famous Dr. *Wallis* agrees with *Des Cartes* in the Solution of that Difficulty, Why the Moon appears to our common Sight so much bigger when near the Horizon, than she doth when near the Meridian; though she be (nearly) one Semi-diameter of the Earth nigher to us in the latter Case, than in the former: Which is, That the Horizontal Moon is capable of being compared with many intervening Objects, interposed Hills, &c. but the Meridional Moon hath nothing to be compared withal; and therefore the Distance between us and her, is judged to be vastly greater, than when she is in the Horizon. He says, It cannot be at all from the Refraction of Vapours near the Horizon, because that can only increase the Altitude of her, but not her Azimuth or Breadth; for the Horizon, in the whole, will always be but a Circle. *Philos. Trans.* N. 187.

The Plane of the Moon's Orbit is inclined to that of the Ecliptick, and makes with it an Angle of about 5 Degrees. *Greg. Astron.* And this Declination varies; and is greatest when the Moon is in the Quadratures, and least when she is in her *Syzygies*.

By means of the Spots in the Moon (which *Herveliu's*, *Grimaldus* and *Ricciolus* gave Names to) the *Lunar Eclipses* are more accurately observed than formerly, to the great Advancement of *Geography* and *Navigation*, in settling the Longitudes of Places: For the Immersions and Emergences of these Spots from the Shadow of the Earth, are most nicely determined.

Although the Moon's Period round the Earth be in 27 Days, 7 Hours,  $\frac{3}{4}$  of an Hour, (which is the *Periodical Month*) yet because in the Space of a Periodical Month, the Earth also with its Satellite, the Moon, is moved on almost an en-



ture Sign, *in Consequentia*; therefore the Point of the Moon's Orbit, in the last Conjunction, or New Moon, will be gotten too far to the Westward: And therefore the Moon cannot come yet to a new Conjunction with the Sun, but wants of it 2 Days and 5 Hours; which must be past before the entire Lunation will be over, and before the Moon hath exhibited all her *Phases*. These 2 Days and 5 Hours therefore being added to the Periodical Month, make the Synodical one, which consists of 29 Days, 12 Hours, and  $\frac{3}{4}$  of an Hour.

Mr. *Flamsteed* makes the Lunar Periodical Month to be 27 days, 7 Hours, 43 minutes, 7 seconds; as, on Enquiry, he assured me.

The other secondary Planets move swifter round their Axes than the Moon; for her (as the Earth's) uniform Revolution round her Axis, is just the Time of her Periodical Month above-mentioned: Which is the Reason that she always obverts the same Face towards us, allowing a little for that Motion of hers which they call her *Libration*. See *Evection* and *Libration*.

The Axis of this Motion is always parallel to its self, and therefore cannot be at Right Angles with the Plane of the Moon's Orbit, (for this, by reason of the Sun's Perturbation of her Motion, is continually changing) but is inclined to it, and is almost at Right Angles with the unchangeable Plane of the Ecliptick.

Tho' the Moon, as well as the Earth, and probably all the Planets, be of a Figure *Oblately Spheroidical*, (that is, having its Diameter at the Equator longer than its Axis) yet the Excess of the Equatorial Diameter in her, is so inconsiderable, that she may well enough pass for a Globe; and perhaps this nearly Spherical Figure of the Moon, may be the Result of her slow Motion round her Axis: For *Jupiter*, which moves the swiftest of any round its Axis, is of a Figure more *Oblate* than any other Planet.

If an Eye were placed in the Moon, it would judge, that the Sun, the Earth, and the other Planets, together with the Fixed Stars, did move from East to West on the Poles of the Ecliptick in a Periodical Month, because in that Space of Time, the Moon turns round her Axis; and these Poles of the Ecliptick would be very remarkable and conspicuous; for the North Pole would be near a Star of the fourth Light, in the third Flexure of *Draco*, which would be but three Degrees distance from the true Pole of the Ecliptick, and the *Southern* would be distinguished by the four Stars in *Xiphia Pifces*, one of which is nearer that Pole of the Ecliptick, than the Pole-star is to the Arctick Pole: And it would be yet more remarkable by the Nearness of the *Nubecula major*.

The apparent Revolution of the Sun (to a Lunar Spectator) about the Moon seemingly at rest, would seem longer than really it is, because of the Moon's being carried along with the Earth round the Sun *in Consequentia*: So that the Natural Day in the Moon would be an entire Synodical Month; wherefore there the Sun will appear to rise but 12 times, but the Fixed Stars 13. And more exactly, in 19 Years the Sun will rise 235 times, and the Fixed Stars 254: And the rising Sun will always be almost an whole Sign forwarder than he was the Day before.

The Lunar Natural Day would appear to be near equally divided into Light and Darkness, because the Axis of the Moon's Revolution is nearly at Right Angles with the Plane of her Or-

bit round the Sun; so that she enjoys a perpetual Equinox: And there can be no *Twilight*, because this Planet hath no Atmosphere. In one half of the Moon's Surface (except just near the Edge of the other Hemisphere) the Earth cannot be seen by our Spectator; whereas in the other half it will be always visible, and seem fix'd in the Heavens like a Star.

### The Famous Sir ISAAC NEWTON'S Theory of the MOON.

This Theory hath been long expected by all the true Lovers of *Astronomy*, was communicated from Sir *Isaac Newton*, to Dr. *Gregory*, *Astron. Professor* at *Oxford*, and by him published in his *Astron. Elem. Philos. & Geomet.* p. 336. From whence, as it was lately translated into *English*, I thought fit to insert it here.

By this Theory, what by all Astronomers was thought most difficult and almost impossible to be done, the Excellent Sir *Isaac Newton* hath now effected; *viz.* To determine the Moon's Place even in her Quadratures, and all other Parts of her Orbit, besides the Syzygies, so accurately by Calculation, that the Difference between that and her true Place in the Heavens, shall scarce be two Minutes, and is usually so small, that it may well enough be reckon'd only as a Defect in the Observation. And this Sir *Isaac Newton* experienced by comparing it with very many Places of the Moon, observ'd by Mr. *Flamsteed*, and communicated to him.

The Royal Observatory at *Greenwich*, is to the West of the Meridian of *Paris* 2 deg. 19 min. Of *Urainburgh* 12 deg. 51 min. 30 seconds. And of *Gedanum* 18 deg. 48 minutes.

The mean Motions of the Sun and Moon, accounted from the Vernal Equinox at the Meridian of *Greenwich*, I make to be as followeth.

The last Day of *December* 1680, at Noon (*Old Stile*) the mean Motion of the Sun was 9 Signs 20 deg. 34 min. 46 seconds. Of the Sun's Apogee, was 3 S. 7 deg. 23. min. 30 sec.

The mean Motion of the Moon at that time, was 6 S. 1 deg. 35 min. 45 seconds. And of her Apogee, 8 S. 4 deg. 28 min. 5 seconds. Of the Ascending Node of the Moon's Orbit, 5 S. 24 deg. 14 min. 35 seconds, &c.

And on the last Day of *December* 1700, at Noon, the mean Motion of the Sun, was 9 S. 20 deg. 43 min. 50 seconds. Of the Sun's Apogee, 3 S. 7 deg. 44 min. 30 seconds. The mean Motion of the Moon was 10 S. 15 deg. 19 min. 50 seconds. Of the Moon's Apogee, 11 S. 8 deg. 18 min. 20 seconds. And of her Ascending Node, 4 S. 27 deg. 24 min. 20 seconds. For in 20 *Julian* Years, or 7305 Days, the Sun's Motion is 20 Revolut. 0 S. 0 deg. 9 min. 4 seconds. And the Motion of the Sun's Apogee, 21 min. 0 seconds.

The Motion of the Moon in the same time, is 247 Revolut. 4 S. 13 deg. 34 min. 5 seconds. And the Motion of the Lunar Apogee, is 2 Revolut. 3 S. 3 deg. 50 min. 15 seconds. And the Motion of her Node, 1 Revolut. 0 S. 26 deg. 50 min. 15 seconds.

All which Motions are accounted from the Vernal Equinox: Wherefore if from them there be subtracted the Recession or Motion of the Equinoctial Point, *in Antecedentia*, during that space, which is 16 min. 0 sec. there will remain the Mo-



tions in reference to the Fix'd Stars in 20 *Julian* Years, viz. the Sun's 19 Revol. 11 S. 29 deg. 52 min. 24 seconds. Of his Apogee, 4 min. 20 seconds. And the Moon's 247 Revol. 4 S. 13 deg. 17 min. 25 seconds. Of her Apogee, 2 Revol. 3 S. 3 deg. 33 min. 35 seconds. And of the Node of the Moon, 1 Revol. 0 S. 27 deg. 6 min. 55 seconds.

According to this Computation the *Tropical Year* is 365 Days, 5 Hours, 48 Minutes, 57 Seconds. And the *Syderal Year* is 365 Days, 6 Hours, 9 Minutes, 14 seconds.

These mean Motions of the Luminaries are affected with various Inequalities: Of which,

1. There are the Annual Equations of the aforesaid mean Motions of the Sun and Moon, and of the Apogee, and Node of the Moon.

The Annual Equation of the mean Motion of the Sun, depends on the Eccentricity of the Earth's Orbit round the Sun, which is  $16\frac{1}{12}$  of such Parts, as that the Earth's mean Distance from the Sun shall be 1000: Whence 'tis called the *Equation of the Centre*; and is when greatest 1 deg. 56 min. 20 seconds.

The greatest Annual Equation of the Moon's mean Motion, is 11 deg. 49 seconds; of her Apogee, 20 min. and of her Node 9 minutes 30 seconds.

And these four Annual Equations are always mutually proportional one to another: Wherefore when any of them is at the greatest, the other three will also be greatest; and when any one lessens, the other three will also be diminished in the same *Ratio*.

The Annual Equation of the Sun's Centre being given, the three other corresponding Annual Equations will be also given; and therefore a Table of *that* will serve for all. For if the Annual Equation of the Sun's Centre be taken from thence, for any Time, and be called P, and let  $\frac{1}{10} P = Q$ ,  $Q + \frac{1}{20} Q = R$ ,  $\frac{1}{2} P = D$ ,  $D + \frac{1}{30} D = E$ , and  $D - \frac{1}{30} D = 2 F$ ; then shall the Annual Equation of the Moon's mean Motion for that time be R, that of the Apogee of the Moon will be E, and that of the Node F.

Only observe here, That if the Equation of the Sun's Centre be required to be added; then the Equation of the Moon's mean Motion must be subtracted, that of her Apogee must be added, and that of the Node subtracted. And on the contrary, if the Equation of the Sun's Centre were to be subtracted, the Moon's Equation must be added, the Equation of her Apogee subtracted, and that of her Node added.

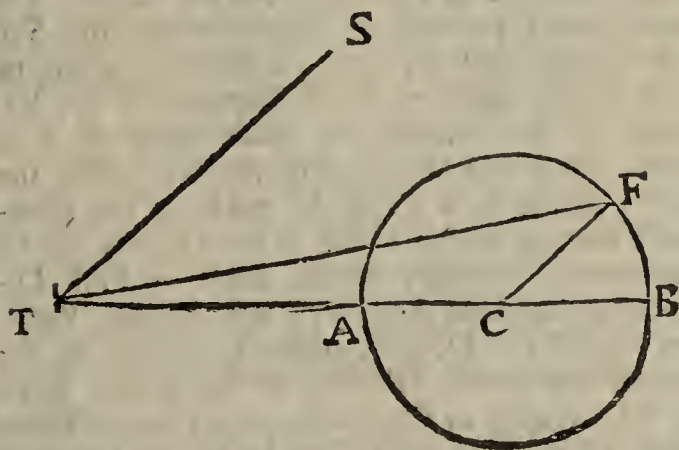
There is also an *Equation of the Moon's mean Motion*, depending on the Situation of her Apogee, in respect of the Sun; which is greatest when the Moon's Apogee is in an Octant with the Sun, and is nothing at all when it is in the Quadratures or or Syzygies. This Equation, when greatest, and the Sun in *Perigæo*, is 3 min. 56 seconds. But if the Sun be in *Apogæo*, it will never be above 3 min. 34 seconds. At other Distances of the Sun from the Earth, this Equation, when greatest, is reciprocally as the Cube of such Distance. But when the Moon's Apogee is any where but in the Octants, this Equation grows less, and is mostly at the same Distance between the Earth and Sun, as the Sine of the double Distance of the Moon's Apogee, from the next Quadrature or Syzygy, to the Radius.

This is to be added to the Moon's Motion while her Apogee passes from a Quadrature with the Sun

to a Syzygy; but this is to be subtracted from it, while the Apogee moves from the Syzygy to the Quadrature.

There is moreover another *Equation of the Moon's Motion*, which depends on the Aspect of the Nodes of the Moon's Orbit with the Sun: And this is greatest, when her Nodes are in Octants to the Sun, and vanishes quite, when they come to their Quadratures or Syzygies. This Equation is proportional to the Sine of the double Distance of the Node from the next Syzygy, or Quadrature; and at greatest, is but 47 seconds. This must be added to the Moon's mean Motion, while the Nodes are passing from their Syzygies with the Sun to their Quadratures with him; but subtracted while they pass from the Quadratures to the Syzygies.

From the Sun's true Place take the equated mean Motion of the Lunar Apogee, as was above shewed, the Remainder will be the Annual Argument of the said Apogee. From whence the *Excentricity of the Moon*, and the *second Equation* of her Apogee may be compared after the manner following (*which takes place also in the Computation of any other intermediate Equations*)



Let T represent the Earth, TS a Right Line joining the Earth and Sun, TA CB a Right Line drawn from the Earth to the middle or mean Place of the Moon's Apogee, equated as above: Let the Angle STA be the Annual Argument of the aforesaid Apogee, TA the least Eccentricity of the Moon's Orbit, TB the greatest. Bisect AB in C; and on the Centre C, with the Distance AC describe a Circle AFB, and make the Angle BCF = to the double of the Annual Argument. Draw the Right Line TF, that shall be the Eccentricity of the Moon's Orbit; and the Angle BTF, is the second Equation of the Moon's Apogee required.

In order to whose Determination, let the mean Distance of the Earth from the Moon, or the Semidiameter of the Moon's Orbit, be 1000000; then shall its greatest Eccentricity TA be 66782 such Parts; and the least TA, 43319. So that the greatest Equation of the Orbit, viz. when the Apogee is in the Syzygies, will be 7 deg. 39 min. 30 seconds, or perhaps 7 deg. 40 min. (for I suspect there will be some Alteration according to the Position of the Apogee in *Cancer* or *Capricorn*). But when it is in Quadrate to the Sun, the greatest Equation aforesaid will be 4 deg. 57 min. 56 seconds; and the greatest Equation of the Apogee 12 deg. 15 min. 4 seconds.

Having from these Principles made a Table of the Equation of the Moon's Apogee, and of the Eccentricities of her Orbit to each Degree of the Annual Argument, from whence the Excentricity TF, and the Angle BTF (*viz.* the second and principal



principal Equation of the Apogee) may easily be had for any Time required; let the Equation thus found, be added to the first Equated Place of the Moon's Apogee, if the Annual Argument be less than 90 Degrees, or greater than 180 Degrees, and less than 270; otherwise it must be subducted from it; and the Sum or Difference shall be the Place of the Lunar Apogee secondarily equated; which being taken from the Moon's Place equated a third time, shall leave the mean Anomaly of the Moon corresponding to any given Time. Moreover, from this mean Anomaly of the Moon, and the before-found Eccentricity of her Orbit, may be found (by means of a Table of Equations of the Moon's Centre made to every Degree of the mean Anomaly, and some Eccentricities, viz. 45000, 50000, 55000, 60000 and 65000) the *Prosthaphæresis* or Equation of the Moon's Center, as in the common way: And this being taken from the former Semi-circle of the middle Anomaly, and added in the latter to the Moon's Place thus thrice equated, will produce the Place of the Moon a fourth time equated.

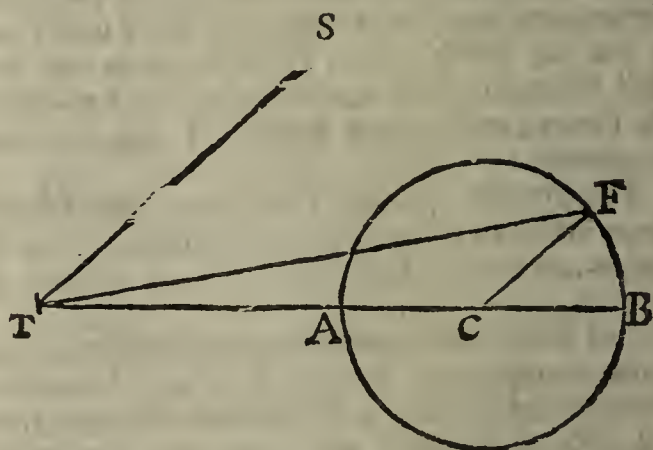
The greatest Variation of the Moon (viz. that which happens when the Moon is in an Octant with the Sun) is nearly, reciprocally as the Cube of the Distance of the Sun from the Earth. Let that be taken 37 min. 25 seconds, when the Sun is in *Perigæo*, and 33 min. 40 seconds, when he is in *Apogæo*; and let the Differences of this Variation in the Octants be made reciprocally as the Cubes of the Distances of the Sun from the Earth; and so let a Table be made of the aforesaid Variation of the Moon in her Octants (or its Logarithms) to every Tenth, Sixth or Fifth Distance of the mean Anomaly: and for the Variation out of the Octants, make, as Radius to the Sine of the double Distance of the Moon from the next Syzygy or Quadrature: : so let the aforesaid Variation in the Octant be to the Variation congruous to any other Aspect; and this added to the Moon's Place before-found in the first and third Quadrant (accounting from the Sun) or subducted from it in the second and fourth, will give the Moon's Place equated a fifth time.

Again, as Radius to the Sine of the Sum of the Distances of the Moon from the Sun, and of her Apogee from the Sun's Apogee (or the Sine of the Excess of that Sum above 360 deg.): : so is 2 min. 10 seconds, to a sixth Equation of the Moon's Place, which must be subtracted, if the aforesaid Sum or Excess be less than a Semi-Circle, but added, if it be greater. Let it be made also, as Radius to the Sine of the Moon's Distance from the Sun: : so 2 deg. 20 seconds to a seventh Equation: which, when the Moon's Light is increasing, add; but when decreasing, subtract; and the Moon's Place will be equated a seventh time, and this is her Place in her proper Orbit.

Note here, The Equation thus produced by the mean Quantity 2 degrees 20 seconds, is not always of the same Magnitude, but is increased and diminished according to the Position of the Lunar Apogee. For if the Moon's Apogee be in Conjunction with the Sun's, the aforesaid Equation is about 54 seconds greater: But when the Apogees are in Opposition, 'tis about as much less; and it librates between its greatest Quantity 3 minutes 14 seconds, and its least 1 minute 26 seconds. And this is when the Lunar Apogee is in Conjunction or Opposition with the Sun's: But in the Quadratures, the aforesaid Equation is to be lessened about 50 seconds, or one minute, when the Apogees of

the Sun and Moon are in Conjunction; but if they are in Opposition, for want of a sufficient Number of Observations, I cannot determine whether it is to be lessened or increased. And even as to the Augment or Decrement of the Equation, 2 minutes 20 seconds above-mentioned, I dare determine nothing certain, for the same Reason, viz. the want of Observation accurately made.

If the sixth and seventh Equations are augmented or diminished in a reciprocal *Ratio* of the Distance of the Moon from the Earth, i. e. in a direct *Ratio* of the Moon's Horizontal Parallax; they will become more accurate: And this may readily be done, if Tables are first made to each Minute of the said Parallax, and to every sixth or fifth Degree of the Augment of the sixth Equation for the sixth, as of the Distance of the Moon from the Sun, for the seventh Equation.



From the Sun's Place, take the mean Motion of the Moon's ascending Node, equated as above; the Remainder shall be the Annual Argument of the Node, whence its second Equation may be computed after the following manner in the preceding Figure.

Let T, as before, represent the Earth; TS a Right Line conjoining the Earth and Sun: Let also the Line TACB, be drawn to the Place of the Ascending Node of the Moon, as above equated; and let STA be the Annual Argument of the Node. Take TA from a Scale, and let it be to AB: : as 56 to 3, or as 11  $\frac{2}{3}$  to 1. Then bisect BA in C, and on C as a Centre, with the Distance CA, describe a Circle as AFB, and make the Angle BCF, equal to double the Annual Argument of the Node before found: So shall the Angle BTF, be the second Equation of the Ascending Node: Which must be added when the Node is passing from the Quadrature to a Syzygy with the Sun, and subducted when the Node moves from a Syzygy towards a Quadrature. By which means the true Place of the Node of the Lunar Orbit will be gained: Whence from Tables made after the common way, the *Moon's Latitude*, and the *Reduction of her Orbit to the Ecliptick*, may be computed, supposing the Inclination of the Moon's Orbit to the Ecliptick, to be 4 deg. 59 min. 35 seconds, when the Nodes are in Quadrature with the Sun; and 5 deg. 17 min. 20 seconds, when they are in the Syzygies.

And from the Longitude and Latitude thus found, and the given Obliquity of the Ecliptick, 23 degrees, 29 minutes, the Right Ascension and Declination of the Moon will be found.

The Horizontal Parallax of the Moon, when she is in the Syzygies at a mean Distance from the Earth, I make to be 57 min. 30 seconds, and her Horary Motion 33 min. 32 seconds, 32 thirds; and



and her apparent Diameter 31 min. 30 seconds. But in her Quadratures, at a mean Distance from the Earth, I make the Horizontal Parallax of the Moon to be 59 min. 40 seconds, her Horary Motion 32 min. 12 seconds, 2 thirds, and her apparent Diameter 31 min. 3 seconds. The Moon in an octant to the Sun, and at a mean Distance, hath her Centre distant from the Centre of the Earth about  $60\frac{1}{2}$  of the Earth's Semi-diameters.

The Sun's Horizontal Parallax I make to be 10 seconds, and its apparent Diameter at a mean Distance from the Earth, I make 32 minutes, 15 seconds.

The Atmosphere of the Earth, by dispersing and refracting the Sun's Light, casts a Shadow as if it were an Opaque Body, at least to the height of 40 or 50 Geographical Miles (by a Geographical Mile, I mean the sixtieth part of a Degree of a great Circle, on the Earth's Surface.) This shadow falling upon the Moon in a Lunar Eclipse, makes the Earth's Shadow be the larger or broader. And to each Mile of the Earth's Atmosphere, is correspondent a Second in the Moon's Disk, so that the Semi-diameter of the Earth's Shadow projected upon the Disk of the Moon, is to be increased about 50 seconds: Or which is all one, in a Lunar Eclipse, the Horizontal Parallax of the Moon is to be increased in the Ratio of about 70 to 69.

Thus far the Theory of this Incomparable Mathematician. And if we had many Places of the Moon accurately observed, especially about her Quadratures, and these well compared with her Places at the same time calculated according to this Theory; it would then appear whether there yet remain any other sensible Equations, which, when accounted for, might serve to improve and enlarge this Theory.

Dr. Greg. *Astr. Elem. Phys. & Geom.*  
pag. 336.

**MOON's Parallax.** There are two Ways of finding the Moon's Parallax.

1. From the Astronomical Tables, the Moon's Place must be accurately had for the Moment of the Observation; and then you must find by Calculation and by the Tables of Refractions, how many Degrees and Minutes the Centre of the ☾ is elevated above the Rational Horizon. At the same Time also exactly, by a large Astronomical Quadrant, Sextant, &c. adjusted with Telescopical Sights, &c. the Elevation of the Moon's Centre above the Horizon of the Observer must be taken in Degrees and Minutes. The Difference between those two Altitudes will be the Parallax of the Moon at the Moment of the Observation, and for that particular Place of the Moon; which being found, the *Horizontal Parallax* may be had by this Analogy; As the Cosine of the Moon's Altitude to Radius :: so is the Quantity of the present Parallax, to the Moon's Horizontal Parallax.

2. Without Astronomical Calculation, the Moon's Parallax may be thus found: Let her Diameter be accurately taken by a good Telescope and Micrometer, when she is on or near the *Meridian*, and when near the *Horizon*, the same Night; the meridian apparent Diameter will be the greatest; the Difference of these two apparent Diameters, being given, in the same Night, you may determine the entire Difference between the Horizontal and Vertical Diameter by the former Ana-

logy. And from this Difference, which is proportional to the Earth's Semi-diameter, both the Moon's Distance and her Parallax may be found by an easy Calculation. And by the best Observation, the Moon's mean Horizontal Parallax hath been found to be about 57 Minutes, and consequently her mean Distance from the Earth about 60 Semi-diameters of the Earth; or about 24000 Miles *English*.

**MOOR** at Sea, signifies the laying out the Anchors of a Ship so, as is best and safest for her Riding. There are several ways of *Mooring* a Ship. Sometimes they *Moor her a-Thwart*, by laying one Anchor on one side of a River, and another right against it on the other side; in order to make both the Cables bear together, as well at Tide of Ebb, as at Flood.

*To Moor Alongst*, is to lay one Anchor right in the middle of the Stream, and another right a head of the Ship, which is done when they are in danger of driving ashore; for by this Means both her Anchors do bear together, and so will save her from falling on either Shore.

*To Moor Water-shot*, is to Moor a Ship in the middle between the two former ways, quartering as it were, neither across the Tide, nor alongst it, but between both. When a Ship comes into a Place of Riding, the Master and his Mates observe on what Point of the Compass the Wind is likeliest to endanger the Ship, and there they lay out an Anchor; and this is called *Mooring for East, North, &c.* according to the Point she is Moored upon. They don't say a Ship is *Moored*, unless she have at least two Anchor's out; except in one Case, and that is, when, though she have but one Anchor out, yet there is a Hawser ashore; and then they say she is Moored with her Head to the Shoar.

**MOORSHEAD**, is the Head of a Copper, or Glas-Still, or Alembick, which is luted on to the Body, or Cucurbit; and hath a Beak, Nose, or Pipe, to let the raised Spirit run down into the Receiver.

**MOOT**, is a Term well understood in the Inns of Court, to be that Exercise or Arguing of Cases, which young Students perform at appointed times, the better to enable them for Practice, and Defence of Clients Causes. In the Inns of Court, there is a *Bayliff*, or *Surveyor of the Inns*, yearly chosen by the Bench, to appoint the *Moot-men* for the Inns of *Chancery*, and to keep account of Performance of Exercises, both there and in the House.

**MOOT-MEN**, are those that argue Reader's Cases (or Moot-Cases) in the Houses of *Chancery*, both in Term-time, and also in Vacations.

**MORAL Quantity.** See *Quantity*.

**MORAL Philosophy**, or *moral Discipline*, is what is usually called *Ethicks* in the Schools, being a practical Science which explains the Nature and Reason of, and withal teaches and instructs us how to acquire that Felicity or Happiness which is agreeable to Human Nature.

**MORAL Actions** or *Acts*, are such as render the Rational and Free Agent *good* or *evil*, and consequently rewardable and punishable, because he doth them.

**MORATUR** or *Demoratur in Lege*, signifies as much as *He demurs*, because the Party goes not forward in Pleading, but rests upon the Judgment of the Court in the Point, who deliberate, and take time to argue and advise thereupon.



**MORBID** [*Morbidus* L.] a Term apply'd by Physicians to those Parts, Humours, &c. in the Body where a Disease lies.

**MORBID** [in *Painting*] is said of fat Flesh very strongly express'd.

**MORBUS** *Regius*, the same that *Icterus*.

**MORSUS** *Diaboli*, is the Term which some Anatomists give to the outer Ends (*i. e.* those next the *Ovaria*) of the *Tubæ Fallopianæ*; because their Edges there appear jagged and torn.

**MORESK** } a sort of Carving, also of Paint-  
**MORISCO** } ing done after the Manner of the Moors, that consists of several Grotesk Pieces and Compartments intermingled promiscuously, which do not contain any perfect Figure either of Man-kind or other Animals, but a wild resemblance of Birds, Beasts, Trees, &c.

**MORTAR-PIECE**, is a kind of very short piece of Cannon, or Ordnance, thick and wide, proper for the discharging of Bombs, Carcasses, Stones, &c. It is usually mounted on a Carriage, the Wheels whereof are very low. Mr. *Anderson*, in his Book of the Gun, saith, That 70 or 80 Degrees of Elevation, is the best for rendring Mortars serviceable, to cast Shells into Towns, Forts, &c. And he saith, That if Mortar-pieces were all, as they ought to be, exactly Similar, and their Requisites of Powder as the Cubes of the

Diameters of their several Bores; and if also their Shells, Bombs, Carcasses, &c. were Similar, then, comparing like with like, their Ranges upon the Plane of the Horizon under the same Degree of Elevation, would be equal; and consequently one Piece being well proved, that is, the Range of the Granado, Bomb, Carcass, &c. being found to any Degree of Elevation, the whole Work of the Mortar-piece would become very easy and exact: But since Mortars are not thus Similar, there is required the Range of the Piece at any convenient degree of Elevation, with its requisite of Powder; and then you must work by the Tables.

**MORTARS** of Mr. *Coehorn*, are made of Hammer'd Iron of about 4 Inches Diameter at the Bore, ten Inches and a half long, and nine Inches in the Chase. They are fixed at an Elevation of 45°. on a Block of *Oak* of about 20 Inches long, and 10  $\frac{1}{2}$  broad, and about 4 thick. These like Hand-Mortars, throw Hand-Grenadoes. They are used chiefly in the bottom of the *Trenches*, where they are placed about a Yard Distance one from another, having each a Soldier to attend it, and there is an Officer to every 40 or 50 of them. They fire sometimes 60 or 70 of these together, which throw their Shells into the *Covertway*, &c. and make a very terrible Slaughter.

## A TABLE



A TABLE of Horizontal Distances.

D.M	Nu.Diff.	D.M	Nu.Diff.	D.M	Nu.Diff.	D.M	Nu.Diff.	D.M	Nu.Diff.	D.M	Nu.Diff.
	521		145		82		4		89		151
30	521	30	5406	30	8851	30	9996	30	8523	30	4806
	190		144		79		7		92		152
1	711	16	5550	31	8930	46	9989	61	8431	76	4656
	181		142		76		10		94		154
30	892	30	5692	30	9006	30	9979	30	8337	30	4502
	177		140		73		13		97		155
2	1069	17	5832	32	9079	47	9966	62	8240	77	4347
	175		138		71		16		99		157
30	1244	30	5970	30	9150	30	9950	30	8141	30	4190
	173		137		69		19		101		157
3	1417	18	6107	33	9219	48	9931	63	8040	78	4033
	172		135		65		22		103		159
30	1589	30	6242	30	9284	30	9909	30	7937	30	4876
	170		133		62		25		107		160
4	1759	19	6375	34	9346	49	9884	64	7830	79	3714
	170		131		61		28		110		161
30	1929	30	6506	30	9407	30	9856	30	7720	30	3553
	168		129		57		31		111		162
5	2097	20	6635	35	9464	50	9825	65	7609	80	3391
	167		128		54		34		113		163
30	2264	30	6763	30	9518	30	9791	30	7496	30	3228
	167		126		51		36		116		165
6	2431	21	6889	36	9569	51	9755	66	7380	81	3063
	166		123		49		40		118		165
30	2597	30	7012	30	9618	30	9715	30	7262	30	2898
	166		122		46		42		120		166
7	2763	22	7134	37	9664	52	9673	67	7142	82	2732
	164		119		43		45		121		166
30	2927	30	7253	30	9707	30	9628	30	7021	30	2566
	163		117		40		49		125		168
8	3090	23	7370	38	9747	53	9579	68	6896	83	2398
	163		115		37		51		126		168
30	3253	30	7485	30	9784	30	9528	30	6770	30	2230
	162		113		34		53		128		169
9	3415	24	7598	39	9818	54	9475	69	6642	84	2061
	160		111		32		58		131		170
30	3575	30	7709	30	9850	30	9417	30	6511	30	1891
	159		108		28		59		132		170
10	3734	25	7817	40	9878	55	9358	70	6379	85	1721
	158		106		26		63		134		171
30	3892	30	7923	30	9904	30	9295	30	6245	30	1550
	158		104		22		65		136		171
11	4050	26	8027	41	9926	56	9230	71	6109	86	1379
	156		102		20		68		138		171
30	4206	30	8129	30	9946	30	9162	30	5971	30	1208
	155		98		16		71		139		172
12	4361	27	8227	42	9962	57	9091	72	5832	87	1036
	153		96		14		73		141		172
30	4514	30	8323	30	9976	30	9018	30	5691	30	864
	151		95		11		76		144		173
13	4665	28	8418	43	9987	58	8942	73	5547	88	691
	151		92		8		78		144		172
30	4816	30	8510	30	9995	30	8864	30	5403	30	519
	150		89		4		82		146		173
14	4966	29	8599	44	9999	59	8782	74	5257	89	346
	148		87		2		84		148		173
30	5114	30	8686	30	10001	30	8698	30	5109	30	173
	147		83		1		86		150		173
15	5261	30	8769	45	10000	60	8612	75	4959	90	000



*The Use of which Table of Horizontal Distances, is this, in Anderson's Words.*

I. Any degree of Elevation under 45 degrees, being given; What degree above 45 degrees, will hit the same Horizontal Distance? Suppose 12 degrees: I look against 12 in the Table, and find 4361, which I look for beyond 45 degrees, and find it against 76 degrees 57 minutes. So I conclude, a Piece charged with the same Quantity of the same Powder, and the same Ball put to either 12 degrees, or 76 degrees 57 minutes of Elevation will range the Shot to the same Horizontal Distance.

Here Note, Suppose a Piece be charged with 1, 2, 3, and 4 Parts of Powder, and the same Ball, and put to those degrees of Elevation, if the upper and lower Ranges be equal, there is no sensible Resistance of the Medium.

II. *June* the 5th 1677. on *Wimbledon-Heath*, I charged the Mortar-piece with 4 Ounces of Powder, and put it to 15 degrees of Elevation; it ranged the Ball to the Horizontal Distance of 659 Paces; with that, I would hit a Mark with the same Piece, Ball, and quantity of Powder, at the Horizontal Distance of 1000 Paces: Then as 659 is to 1000, so is 5261 the Tabular Number of 15 degrees to 7983, which gives in the Table 25 degrees 47 minutes, and 63 degrees 16 minutes; to hit a Mark at the Horizontal Distance of 1000 Paces.

III. *Feb.* the 12th 1677. on *Wimbledon-Heath*, a Piece whose Length of its Chafe is 18 Inches, and Diameter of Bore 3 Inches, charged with 8 Ounces of Powder, and laid to 10 degrees of Elevation, ranged its Shot to the Horizontal Distance of 805 Paces: With that I would hit a Mark at the Horizontal Distance of 2112 Paces: that is, 2 *English* Miles. Then as 805 is to 2112, so is 3734, the Tabular Number at 10 degrees, to 9797, which gives in the Table 38 degrees 41 minutes, and 50 degrees 25 minutes, to hit a Mark at the Horizontal Distance of 2112 Paces, *viz.* 2 *English* Miles.

N. B. Since this, our Excellent Mathematical Instrument-maker, Mr. *John Rowley*, hath contrived this Table on a Scale of Box, where, by sliding only a fiducial Edge of Brass over the Diagonals of the Distance required, both the Elevations, upper and lower, are shewn at the same time.

Mr. *Anderson* gives us also the following TABLE of the Requisite Weight of Powder for all Mortars, from 6 to 20 Inches Diameter.

Inc.	Decim.	Pounds.	Ounces.
6.	0		13
6.	5	1.	01
7.	0	1.	05
7.	5	1.	10
8.	0	2.	00
8.	5	2.	06
9.	0	2.	14
9.	5	3.	06
10.	0	3.	14½
10.	5	4.	08
11.	0	5.	03
11.	5	5.	15
12.	0	6.	12
12.	5	7.	10
13.	0	8.	09
13.	5	9.	10
14.	0	10.	11½
14.	5	11.	14
15.	0	13.	03
15.	5	14.	09
16.	0	16.	16
16.	5	17.	09
17.	0	19.	03
17.	5	20.	15
18.	0	22.	12½
18.	5	24.	11
19.	0	26.	13
19.	5	28.	14
20.	0	31.	04.

*The Use of this TABLE is Plain and Easy.*

If you would know the Quantity of Powder requisite to load a Mortar of 15 Inches Diameter; against 15 Inches you have 13 Pounds 3 Ounces, and that is the true Weight of Powder required.

MORTGAGE, in Law, signifies a Pawn of Land, or Tenements, or any thing moveable, laid or bound for Money borrowed, to be the Creditors for ever, if the Money be not paid at the Day agreed upon: And the Creditor holding Land, or Tenement upon this Bargain, is called Tenant in Mortgage. He that pledgeth this Pawn or Gage, is called the Mortgager, and he that taketh it, the Mortgagee.

MORTIFY, The Chymists say a Thing is Mortify'd, when its outward Form is altered or destroyed, as particularly when *Mercury*, or any other Metal is dissolved in an *Acid Menstruum*. Sometimes they say also, that Spirits are Mortified, when they are mix'd with such Things as destroy their Strength, and hinder their Operation.

MORT-



**MORTIFICATION** [with *Physicians*, &c.] a Disease in which the natural Juices of any part quite lose their proper Motions, and by that means fall into a fermentative one, and corrupt and destroy the Texture of the part.

**MORTISE** or *Mortaise*, is the Workmens Word in Architecture for the Hole made in one Piece of Timber to receive the Tennon of another Piece.

**MORTMAINE**, a Term in Law, signifying an Alienation of Lands and Tenements to any Guild, Corporation, or Fraternity; their Successors, as Bishops, Parsons, Vicars, &c, which may not be done without the King's Licence, and the Lord of the Manor, or of the King alone, if it be immediately holden of him.

**MORTMAIN Statute**: There was a Statute made in 7 Ed. 1. *de Terris in manum mortuam non ponendis*; to restrain the Donation of any Lands or Tenements to religious or pious Uses, where they lay in a *Dead Hand*, without Succession or due Service to the Lord and the King. After which Statute the Lands so given away were forfeited to the King, if the immediate Lord of the Fee made not his Claim within a Year after such Alienation.

When the King by special Licence dispensed with the *Statute of Mortmain*, there was a previous Inquisition *ad quod Damnum*, and a Return upon Oath that it would be no Prejudice to the Dignity and Revenues of the Crown. This Law is now relaxed by *Stat. 39 Eliz. c. 5.* of giving Lands to Hospitals; and by 14 of *Car. II. c. 9.* about purchasing Lands and Tenements for the Poor within *London* and *Westminster*.

**MORTUARY**, is a Gift left by a Man at his Death, to his Parish-Church, for the recompence of his Personal Tythes and Offerings, not duly paid in his Life-time. A *Mortuary* is not properly and originally due to an Ecclesiastical Incumbent from any, but those only of his own Parish. But by Custom in some Places of this Kingdom, they are paid to the Parsons of other Parishes, as the Corps passes through them.

**MOSAIC Work**, is corruptly so called; it should be *Musaick*; in Latin *musivum Opus*, and sometimes 'tis called also *Pavimenta Tessellata*.

**MOSAICK Work**, was anciently used only in Pavements, and began in *Rome* about *Sylla's* time; who made a Pavement of *Mosaick Work* at *Preneſte* in the Temple of *Fortune*, about 170 Years before Christ. It was called *Lithostroton*, in *Greek*, only a Stone Pavement; but, it is understood of Figures made or represented by inlaying of small Stones, or rather pieces of Stone of different Colours; by the variety of which, many Curious Figures may be wrought. Afterward it came to be in Fashion for the Insides of the Walls of Rooms; and now-a-days they work it with Shells, or small Pieces of Glas variously Colour'd and Figured: 'Tis a very pleasant and a lasting Ornament, when 'tis curiously and excellently done.

**MOTHER Tongues**, in Latin, *Matrices Linguae*, are such Languages as seem to have no Dependence upon, Derivation from, or Affinity with one another. 'Tis a Conjecture commonly received, That at the Confusion of Languages at the Tower of *Babel*, there were formed 70, or 72 severally distinct Languages: But Bishop *Wilkins* thinks 'tis probable there were not so many, and that at the first Dispersion, Men did not divide into so many Colonies. But now the Languages used in the World, do far exceed that Number: If you will

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believe *Pliny* and *Strabo*, there was a Town in *Colchos* called *Dioscuria*, to which Men of three hundred Nations, and as many several Languages, did resort for Trading. Some of the *American* Historians relate, That in every 80 Miles of that vast Country, and also in almost every particular Valley of *Peru*, the Inhabitants had a distinct Language or Mother-Tongue by themselves. And *Purchas* tells us, *Pilgr. Lib. 8. Sect. 4. Cap. 1.* That by Converse and Enquiry, in the Northern Parts of *America*, about *Florida*, he found more than 1000 different Languages amongst the Inhabitants of those Places.

*Joseph Scaliger* affirms there are no more than Eleven Mother-Tongues used in *Europe*; of which Four are of more general and large Extent, and the other Seven of a narrower Compass and Use.

1. The *Greek*, which was anciently of very great Extent, not only in *Europe*, but in *Asia* and *Africk* too, where several Colonies of that Nation were planted; by which Dispersion and Mixture with other People, it did degenerate into several *Dialects*. Besides those Four that are commonly noted, the *Doric*, *Ionic*, *Aeolic*, *Attic*, *Herodotus* doth mention Four several *Dialects* of the *Ionic*. The Inhabitants of *Rhodes*, *Cyprus*, *Crete* had each of them some Peculiarity in their Language: And the present *Coptic* or *Aegyptian* seems, both from the Words and the Character, to be a Branch of this Family, and was probably spread amongst that People in the Days of *Alexander the Great*, upon his conquering of them; tho' some conceive that there were at least 30000 Families of *Greeks* planted in that Country long before his Time.

2. The *Latin*, tho' this be much of it a Derivation from the *Greek*, (of which the now *French*, *Spanish*, and *Italian*, are several Off-springs and Derivations) had anciently Four several *Dialects*, as *Petrus Crinitus* shews out of *Varro*.

3. The *Teutonic* or *German*, is now distinguished into *Upper* and *Lower*. The *Upper* hath two notable *Dialects*: 1. The *Danish*, *Scandian*, or perhaps the *Gothick*; to which belongs the Language used in *Denmark*, *Norway*, *Swedeland*, and *Island*. 2. The *Saxon*, to which appertain the several Languages of the *English*, the *Scotch*, the *Frisians*, and those on the North of *Elbe*.

4. The *Sclavonic* is extended, tho' with some Variation, through many large Territories, *Muscovia*, *Poland*, *Bohemia*, *Vandalia*, *Croatia*, *Lithuania*, *Dalmatia*; and is said to be the Vulgar Language used amongst Sixty several Nations.

The Languages of lesser Extent, are,

1. The *Albanese*, or Old *Epirotic*, now used in the Mountainous Parts of *Epirus*.

2. The *European Tartar*, or *Scythian*, from which some conceive our *Irish* to have had its Original.

As for the *Turkish* Tongue, that is originally no other but the *Asiatick Tartar* mixed with *Armenian* and *Persian*, some *Greek*, and much *Arabic*.

3. The *Hungarian*, used in the greatest Part of that Kingdom.

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4. The *Finnic* used in *Finland* and *Lapland*.

5. The *Cantabrian*, used amongst the *Biscainers* who live near the Ocean on the *Pyrene* Hills, bordering both upon *France* and *Spain*.

6. The *Irish*, in *Ireland*, and from thence brought over into some Parts of *Scotland*; tho' Mr. *Camden* would have this to be a Derivation from the *Welsh*.

7. The Old *Gaulish* or *British*, which is yet preserved in *Wales*, *Cornwal*, and *Britain* in *France*.

To this number Mr. *Brerewood* doth add Four others, *viz.*

1. The *Arabick*, now used in the steep Mountains of *Granata*; which yet is a Dialect from the *Hebrew*, and not a Mother-Tongue.

2. The *Cauchian*, in *East-Friesland*.

3. The *Illyrian*, in the Isle of *Veggia*.

4. The *Fazygian*, on the North-side of *Hungary*.

MOTION, is a continual and successive Mutation or Change of Place. All Motion may be consider'd either *Absolutely* or *Relatively*. *Absolute Motion* is the Change of the *Locus Absolutus* of any moving Body, and therefore its Celerity will be measured by the Quantity of the *Absolute Space*, which the Moveable hath run through. But *Relative Motion* is a Mutation of the *Relative* or *Vulgar Place* of the moving Body, and so hath its Celerity accounted or measured by the Quantity of *Relative Space* which the Moveable runs over.

All Motion is of itself rectilinear, or made according to strait Lines, with the same constant uniform Velocity, if no external Cause make any Alteration in its Direction.

If a Body, moving uniformly, and with the same Degree of Velocity, pass over two Spaces, the Times of the Motions will be as the Spaces; as is very plain to him that will consider it.

If a Body move through two Spaces in equal Times, those Spaces will be to one another as the Velocities of the Motions.

If two Bodies move uniformly, but with unequal Velocities, through the same Space, the Times will be as the Velocities.

If two Bodies, moving uniformly, go with unequal Velocities, the Spaces which will be past over by them in unequal Times, will be to one another in a Ratio compounded of that of the Velocities and that of the Times. *Galileus, de Motu Local. Dial. 3. Giorn. terza.*

If any Bodies are impelled upwards by different Forces, they will be raised to different Heights; which Heights will be to one another as the Squares of their Velocities.

And if Bodies fall from different Altitudes, the Celerities will be to one another as the Squares of such Altitudes.

It is a Property of Motion, that the Parts, which retain given Positions to their wholes, do partake of the Motions of those wholes. For all the Parts of revolving Bodies endeavour to recede from the Axe of Motion; and the Impetus of Bodies

moving forwards, arises from the joint Impetus of all the Parts. Therefore, if surrounding Bodies are mov'd, those that are relatively at rest within them, will partake of their Motion. Upon which account, the true and absolute Motion a Body cannot be determin'd by the Translation of it from those which only seem to rest: For the external Bodies ought not only to appear at rest, but to be really at rest. For otherwise all included Bodies, beside their Translation from near the surrounding ones, partake likewise of their true Motions; and tho' that Translation was not made they would not be really at rest, but only seem to be so. For the surrounding Bodies stand in the like Relation to the surrounded, as the exterior Part of a whole does to the interior, or as the Shell does to a Kernel; but, if the Shell moves, the Kernel will also move, as being part of the whole, without any removal from near the Shell.

A Property near a-Kin to the preceeding, is this, that if a Place is mov'd, whatever is placed therein moves along with it; and therefore a Body, which is mov'd from a Place in Motion, partakes also of the Motion of its Place; upon which account all Motions from Places in Motion, are no other than parts of intire and absolute Motions; and every intire Motion is composed out of the Motion of the Body out of its first Place, and the Motion of this Place out of its Place, and so on; until we come to some immoveable Place.

Wherefore intire and absolute Motions can be no otherwise determin'd than by immoveable Places; and for that reason I did before refer those absolute Motions to immoveable Places, but relative ones to moveable Places. Now no other Places are immoveable, but those that, from infinity to infinity, do all retain the same given Positions one to another; and upon this account, must ever remain unmov'd; and do thereby constitute, what I call, immoveable Space.

The Causes by which true and relative Motions are distinguished, one from the other, are the Forces impress'd upon Bodies to generate Motion. True Motion is neither generated nor alter'd, but by some force impress'd upon the Body moved: but relative Motion may be generated or alter'd without any force impress'd upon the Body. For it is sufficient only to impress some force on other Bodies with which the former is compar'd, that by their giving way, that relation may be chang'd, in which the relative Rest or Motion of this other Body did consist.

Again, true Motion suffers always some change from any force impress'd upon the moving Body; but relative Motion does not necessarily undergo any change, by such forces, for if the same Forces are likewise impress'd on those other Bodies, with which the Comparison is made, that the relative Position may be preserved, then that Condition will be preserved, in which the relative Motion consists. And therefore, any relative Motion may be changed, when the true Motion remains unalter'd, and the relative may be preserv'd, when the true suffers some change. Upon which accounts, true Motion does by no means consist in such relations.

The Effects which distinguish absolute from relative Motion are, the Forces of receding from the Axe of circular Motion. For there are no such Forces in a circular Motion purely relative, but in a true and absolute circular Motion, they are greater



greater or less, according to the Quantity of the Motion. If a Vessel, hung by a long Cord, is so often turned about that the Cord is strongly twisted, then fill'd with Water, and held at rest together with the Water; after by the sudden Action of another Force, it is whirled about the contrary way, and while the Cord is untwisting it self, the Vessel continues for some time in this Motion; the Surface of the Water will at first be plain, as before the Vessel began to move: but the Vessel, by gradually communicating its Motion to the Water, will make it begin sensibly to revolve, and recede by little and little from the Middle, and ascend to the Sides of the Vessel, forming itself into a concave Figure, (as I have experienced) and the Swifter the Motion becomes, the Higher will the Water rise, till at last, performing its Revolutions in the same times with the Vessel, it becomes relatively at rest in it. This Ascent of the Water shews its endeavour to recede from the Axe of its Motion; and the true and absolute circular Motion of the Water, which is here directly contrary to the relative, discovers itself, and may be measured by this endeavour, at first, when the relative Motion of the Water in the Vessel was greatest, it produc'd no endeavour to recede from the Axe; the Water shew'd no tendency to the Circumference, nor any ascent towards the Sides of the Vessel, but remain'd of a plain Surface, and therefore its true circular Motion had not yet begun. But afterwards, when the relative Motion of the Water had decreas'd, the Ascent thereof towards the Sides of the Vessel, prov'd its endeavour to recede from the Axe; and this endeavour shew'd the real circular Motion of the Water perpetually increasing, till it had acquir'd its greatest Quantity, when the Water rested relatively in the Vessel. And therefore this endeavour does not depend upon any translation of the Water in respect of the ambient Bodies, nor can true circular Motion be defin'd by such translations. There is only one real circular Motion of any one revolving Body, corresponding to only one Power of endeavouring to recede from its Axe of Motion, as its proper and adequate effect: but relative Motions in one and the same Body are innumerable, according to the various Relations it bears to external Bodies, and like other Relations, are altogether destitute of any real effect, any otherwise than they may perhaps participate of that only true Motion. And therefore in their System who suppose that our Heavens, revolving below the Sphere of the fix'd Stars, carry the Planets along with them; the several Parts of those Heavens, and the Planets, which are indeed relatively at rest in their Heavens, do yet really move, for they change their Position one to another (which never happens to Bodies truly at rest) and being carried together with their Heavens, participate of their Motions, and as parts of revolving wholes, endeavour to recede from the Axe of their Motions.

Wherefore relative Quantities are not the Quantities themselves, whose Names they bear, but those sensible Measures of them (either accurate or inaccurate) which are commonly used instead of the measured Quantities themselves. And if the meaning of Words is to be determin'd by their use; then by the Names Time, Space, Place and Motion, their Measures are properly to be understood; and the Expression will be unusual, and purely Mathematical, if the measured Quantities themselves are meant; upon which account, they do strain the Sacred Writings, who there interpret

those Words for the measured Quantities. Nor do those less defile the Purity of Mathematical and Philosophical Truths, who confound real Quantities themselves with their relations and vulgar Measures.

It is indeed a Matter of great Difficulty to discover, and effectually to distinguish the true Motions of particular Bodies from the Apparent: because the Parts of that immoveable Space in which those Motions are performed, do by no means come under the Observation of our Senses. Yet the thing is not altogether desperate; for we have some Arguments to guide us, partly from the apparent Motions, which are the Differences of the true Motions; partly from the Forces, which are the Causes and Effects of the true Motions. For Instance, if two Globes kept at a given distance one from the other, by means of a Cord that connects them, were revolv'd about their common centre of Gravity; we might, from the Tension of the Cord, discover the endeavour of the Globes to recede from the Axe of their Motion, and from thence we might compute the Quantity of their Circular Motions, and then if any equal Forces should be impress'd at once on the alternate Faces of the Globes to augment or diminish their circular Motions; from the increase or decrease of the Tension of the Cord, we might infer the increment of their Motions; and thence would be found, on what Faces those Forces ought to be impress'd, that the Motion of the Globes might be most augmented, that is, we might discover their hindermost Faces, or those which, in the circular Motion, do follow. But the Faces which follow being known, and consequently, the opposite ones that precede, we should likewise know the Determination of their Motions, and thus we might find both the Quantity and the Determination of this circular Motion, even in an immense Vacuum, where there was nothing external or sensible with which the Globes could be compared. But now if in that Space some remote Bodies were placed that kept always a given Position one to another, as the fix'd Stars do in our Regions; we could not indeed determine from the relative Translation of the Globes among those Bodies, whether the Motion did belong to the Globes or to the Bodies. But if we observ'd the Cord, and found that its Tension was that very Tension which the Motions of the Globes required, we might conclude the Motions to be in the Globes, and the Bodies to be at rest; and then, lastly, from the Translation of the Globes among the Bodies, we should find the Determination of their Motions. But how we are to collect the true Motions from their Causes, Effects, and apparent Differences; and *vice versa*, how from the Motions, either true or apparent, we may come to the Knowledge of their Causes and Effects, shall be explain'd more at large in the following Tract, for to this end it was that I compos'd it.

#### MOTION; Its Laws.

The Incomparable Sir Isaac Newton gives but these Three Laws of Motion, which may be truly called *Laws of Nature*.

1. That every Body will continue in its State, either of Rest or Motion uniformly forward in a Right Line, unless it be made to change that State by some Force impress'd upon it.

2. That



2. That the Change of Motion is proportionable to the moving Force impressed; and is always according to the Direction of that Right Line in which the Force is impressed.

3. That *Reaction* is always equal and contrary to *Action*; or, which is all one, the mutual *Actions* of two Bodies one upon another are equal, and directed towards contrary Parts: As when one Body presses and draws another, 'tis as much pressed or drawn by that Body.

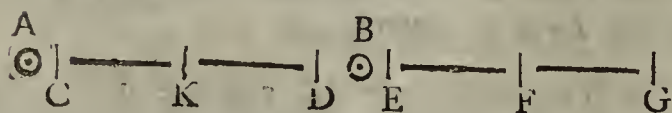
The Quantity of any Motion is discoverable by the joint Consideration of the Quantity of Matter in, and the Velocity of the moving Body: For the Motion of any Whole, is the Sum of the Motions of all the Parts. And consequently if a Body be twice as great as another, and be moved with an equal Degree of Velocity, the Quantity of the Motion is *double* in the Former; but if the Velocity be also double, then the Quantity of the Motion is *Quadruple* of that of the latter. *Newton's Princip.*

The Quantity of Motion, which is found by taking either the Sum of Motions made the same way, or the Difference of those which are made contrary ways, is not at all changed by the *Action* of Bodies one upon another. For *Action* and *Reaction* are always equal, (by *Law 3.*) wherefore (by *Law 2.*) they must needs produce equal Changes in the Motions towards contrary Parts: Wherefore, if the Motions be both according to the same Direction, whatsoever is added to the Body to be moved, or which is forced to give place, is subducted from the Body which moves, or drives away the other, so that the Sum remains the same as before. But if the Bodies meet with contrary Directions, there must be an equal Subtraction of the Motion of each, and consequently the *Difference* of the Motions made towards the contrary parts, will remain the same. Suppose the Spherical Body A to be thrice as big as B, and of the like Figure. Let A have two Degrees of Velocity, and B pursue it with ten Degrees of Velocity: Wherefore the Quantity of the Motion of A to B, is as 6 to 10; therefore the Sum of the Motions of both is 16. Suppose then B to overtake A, and to give it 3, 4, or 5 Degrees of Velocity; 'tis plain it must lose just as much itself: Wherefore A will go on with 9, 10, 11 Parts of Velocity: and B will follow after with 7, 6, or 5. So that the Sum will still be 16; and thus will it always be. *Idem.*

Mr. Keil, in his *Lectiones Physicæ*, proves this distinctly, by branching of it into two Theorems. See p. 127.

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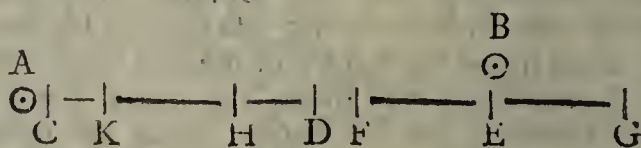
Let the Body A move according to the Direction CD, and in its way strike against the Body B; which suppose to be either at rest, or moving

on more slowly than A, and according to the same Direction with it: I say, the Sum of the Motions in both Bodies, towards the same Parts, that is, from C towards D, will be the same as before. Let CD express the Motion of A from C to D; and if B be in Motion too, let EF express its Motion the same way. Then will the Sum of both Motions be expressed by  $CD + EF$ . But because *Action* and *Reaction* are always equal, and towards contrary Parts; if FG express the Motion impressed on B by the Stroke of A; DK, equal to it, must express the Motion impressed on A by the Stroke of B, with a contrary Direction from D towards C. Wherefore since  $DK = FG$ , CK will express the Motion of the Body A after the Shock, and EG the Motion of B; and therefore the Sum of both will be  $CK + EG$ . But since  $FG$  is supposed  $= DK$ , if you add CK and EF to both,  $EG + CK$  must be equal to  $CD + EF$ . Wherefore the Sum of the Motions of both is the same as at first.

And if FG be equal to CD, the Points K and C must be coincident; that is, CK will be  $= 0$ , and consequently the Body A, after the Occurſe or Shock, will be quite at rest. But if FG be greater than CD, the Point K must be found somewhere beyond or to the Left Hand of C; and the Motion of A will become changed towards the contrary Parts, and the Sum of the Motions towards G will be as  $EG - CK$ : And because  $FG = CK$ , add to both  $EF - CK$ , and it will be that  $EF + FG - CK$ , (*i. e.*)  $EG - CK = EF + DK - CK$ , (*i. e.*)  $EF + CD$ . From whence 'tis plain that the Sum of the Motions towards the same Parts (which in this Case is their Difference towards contrary Parts) continues the same after the Shock as before.

COR. After the same manner it will appear, if many Bodies, moving with the same Direction, should strike against one another, the Sum of their Motion, after that, will be the same as before.

II. If Two Bodies move towards each other with exactly contrary Directions, the Sum of their Motions towards the same Parts (which is all one as the Difference of them towards contrary Parts) will continue the same after the Shock as before it.



Let the Body A move from C towards D, and let CD express its Line of Motion; and let the Body B be moving at the same time with a quite contrary Direction from E to F, and let EF express its Motion. Let DH be supposed equal to EF; so shall CH, which is the Difference of their Motion towards contrary Parts, express the Sum of the Motions made towards G. I say then, that the same CH is the Sum of their Motions towards G, as well after the Shock as before it: For after the Shock, suppose the Motion of B to be changed, and to be now towards G, and let the Line EG represent it; wherefore the Force impressed upon B after the Shock, and which carries it towards G, will be equal to the Sum of the Motions EF and GF, and consequently be expressed by FG: For in that Right Line, the Motion EF, towards F, is destroyed; and



and the new one, E G, towards G, produced. But now since the impulsive Force in both Bodies acts equally towards contrary Parts, if D K be made equal to F G, this shall represent the Force impressed on the Body A, and carry it in a contrary Direction to its former Motion: So that if the Line of Motion D K, be taken from the Line C D, there will remain C K representing the true Motion of A towards G. But because D K = F G, and D H = F E; D K — D H (i.e. K H) = F G — F E (i.e.) E G: And consequently since K H = E G, K H will represent the Motion of the Body B, after the Shock; but C K represents the Motion of A after it: Wherefore C A is the Sum of the Motion in both Bodies towards G.

If F G had been equal to C D, then the Points, K and C would be coincident, and the Motion of A will be quite destroyed, (i.e.) after the Shock A will be perfectly at rest, and C A will be equal to E G.

But if F G be greater than C D, the Point K will fall to the Left Hand of C, and the Motion of the Body A will be from C towards K. But (because F G = D K, and F E = D H) K H = E G; wherefore taking C K from both, C H must be equal to E G — C K; which represents the Sum of the Motions made towards the same Parts, and their Difference towards contrary ones after the Shock: Wherefore the Sum of the Motions towards the same Parts remains the same after, as before the Shock.

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1. If any Agent, as A, produce any Effect, as E; then an Agent, as 2 A, will produce an Effect, as 2 E; 3 A, as 3 E, &c. *cæteris paribus*. And universally, if  $m$  be put for the Exponent of the Power,  $m A$ , as  $m E$ .

2. Wherefore if any Force, as V (which stands for *Vis*) move any Weight, Mass, or Body, as P; the Force, which is as  $m V$ , shall move  $m P$ , *cæteris Paribus*; viz. with the same Celerity, or through the same Space in the same Time.

3. If the Force in the given Time T, move any Weight thro' the Space or Length L, in the Time  $n T$ , it shall move it through the Space  $n L$ .

4. Wherefore if the Force V, in the Time T, move any Weight, as P thro' the Length or Space L, the Force  $m V$  in the Time  $n T$ , shall move  $m P$  thro' the Space  $n L$ : And consequently as V T, (the Rectangle under the Force and Time) is to P L the Rectangle under the Weight and Distance :: so is  $m n V T$ , to  $m n P L$ .

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$\frac{m L}{n T} \frac{m}{n} C$ . That is, the Degrees of Celerity will be in a *Ratio* compounded directly of the Lengths, and reciprocally of the Times.

6. Since as V T. P L ::  $m n V T$  to  $m n P L$ , it will be as V.  $\frac{P L}{T} :: m V. \frac{m n P L}{n T}$  That is, V. P C ::  $m V. m P C = m P \times$  by C; or =  $P \times$  by  $m C$ .

7. That is, if the Force V be able to move the Weight P, according to the Celerity C; then will the Force  $m V$ , move the same Weight P, in the Celerity  $m C$ ; or with the bare Celerity C, the Weight  $m P$ : Or, in one word, it will be able to move any Weight with that Celerity, if the Product of the Weight multiplied by the Celerity, be  $m P C$ .

8. And on this depends the Reason of the Construction of all manner of Engines and Machines, for facilitating of Motion, viz. That in whatever Proportion the Weight be increased, the Celerity be decreased accordingly: From whence it comes that the Product of the Celerity multiplied by the Weight, for moving the same Force, is always the same, viz. V : P C ::

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For, V : P C ::  $m n V. m n P C :: V + m n V$   
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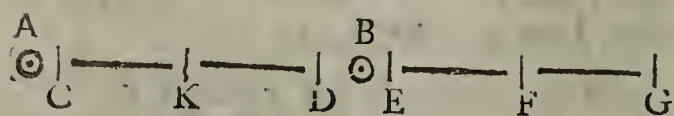
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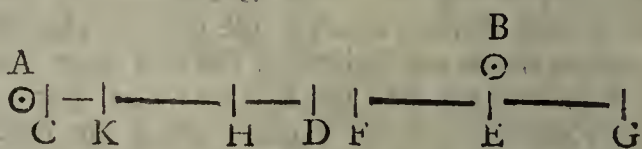
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8. And on this depends the Reason of the Construction of all manner of Engines and Machines, for facilitating of Motion, viz. That in whatever Proportion the Weight be increased, the Celerity be decreased accordingly: From whence it comes that the Product of the Celerity multiplied by the Weight, for moving the same Force, is always the same, viz. V : P C :: N.  $m P + \frac{1}{m} C$ : That is, P C.

9. If the Weight P, by the Force V, carried according to the Celerity C, strike directly against the Weight  $m P$ ; which, tho' supposed at rest, yet is capable of being moved; both the Bodies after the stroke, will be carried with the Celerity  $\frac{1 + m}{1} C$ . For, by reason the same Force is impelled to move the greater Body, the Celerity of it will be lessened after the same Ratio, viz. V : P C :: V :  $\frac{1 + m}{1} P \times \frac{1}{1 + m} C = P C$ . And therefore the Impetus, (or Product of the Weight multiplied by the Celerity) of the other will be  $\frac{1}{1 + m} P C$ ; and of the Remaining one  $\frac{1}{1 + m} m P C$ .

10. If against the Weight P, moved by the Force V, with the Celerity C, another Weight or Body shall strike directly, moving the same way, but with greater Celerity: As suppose the Weight  $m P$ , with the Celerity  $n C$ , (which therefore will be carried forward with the Force  $m n V$ .) After this they will both move forward with the Celerity  $\frac{1 + m n}{1 + m} C$ .

For, V : P C ::  $m n V. m n P C :: V + m n V$   
 $\left( \frac{1 + m n V}{1} \right) \frac{1 + m n}{1} P C$ : which is equal to  
 $\frac{1 + m}{1} P \times$  by  $\frac{1 + m n}{1 + m} C$ .



And therefore the Impetus of the preceeding Body will be  $\frac{1+m^2}{1+m} P C$ : and of the following,  $\frac{1+m^2}{1+m} m P C$ .

II. If the Weights or Bodies are carried contrary ways, they will meet, and mutually strike against each other.

Suppose the Weight P, carried by the Force V, with the Celerity C, towards the Right Hand; and the Weight m P, with the Celerity n C, (and consequently carried by the Force m n V) toward the Left Hand: Then may the Impetus, Direction, and Celerity of each be thus calculated.

The Body which moved towards the Right Hand, if the other had been at rest, would have given it the Celerity  $\frac{1}{1+m} C$ , (by the 9th;)

and consequently the Impetus  $\frac{1}{1+m} m C P$ ,

of moving to the Right Hand; and would have retained to it self the same Celerity, and the

Impetus  $\frac{1}{1+m} m P C$ , also towards the Right

Hand. And the other Body, carried toward the Left Hand, would, if the former had been at rest,

have given it the Celerity  $\frac{m^2}{1+m} C$ ; and there-

fore the Impetus  $\frac{m^2}{1+m} m P C$ , towards the

Left Hand, by the same Reason; and it would have retained to its self the same Celerity, and

therefore the Impetus  $\frac{m^2}{1+m} m P C$  also toward the Left Hand.

Wherefore since the Motion was made both ways, the Aggregate of the Impetus of the former Body, will arise out of the Impetus

$\frac{1}{1+m} P C$  to the Right, and  $\frac{m^2}{1+m} P C$  to the

Left: And therefore in reality, it will move either to the Right or Left, according as that or this is greater, and by an Impetus, which is the Difference between those 2 Impetus's. That is, Supposing + to signify to the Right Hand, and - to

the Left, the Impetus will be  $\frac{1}{1+m} P C -$

$\frac{m^2}{1+m} P C$ , which is equal to  $\frac{1-m^2}{1+m} P$ . And

the Celerity will be  $\frac{1-m^2}{1+m} C$ , (and towards

the Right or Left Hand, according as 1 or m n is the greater Quantity.)

And in like manner the Impetus of the other Body, which first moved towards the Left Hand, will be  $\frac{1}{1+m} m P C - \frac{m^2}{1+m} m P C =$  to

$\frac{m^2}{1+m} m P C$ . And the Celerity will be

$\frac{1-m^2}{1+m} C$ , and the Direction to the Right or

Left Hand, according as 1, or m n, is the greater Quantity.

12. But if the Bodies neither move on in the same way directly, nor directly contrary to one another, but do encounter one another obliquely; then the preceeding Calculus must be moderated, according to the Measure of that obliqui-

ty: And the Impetus of the Body striking obliquely, is to the Impetus it would have had, if it had gone directly: as the Radius to the Secant of the Angle of the Obliquity.

Which Consideration duly applied to the former Calculus, will determine with what Impetus, Celerity, and Direction, the obliquely encountering Bodies shall move afterward.

And there is the very same Ratio of the Gravitation of heavy Bodies, which descend Obliquely to their Gravitation, supposing them to have descended perpendicularly; as we elsewhere demonstrate.

13. If the Bodies, which thus encounter or strike one against another, are not infinitely hard (as hath hitherto been supposed) but do yield something to the Stroke, but yet so as that by a Spring, or Elastick Force, they can recover their Figure or Position again: It may happen from hence, that those Bodies may rebound back from one another mutually, which otherwise would have moved on together; (and this more or less, according to the Quantity of the Elasticity) viz. if the Elastick Force exceed the Progressive.

In Motions which are accelerated and retarded, the Impetus in each Moment is to be esteemed that which agrees to the degree of Celerity then acquired. But when the Motion is made in a Curve Line, that is to be accounted the Line of Direction of the Motion in each Moment, which is truly the Tangent to the Curve in that Point. And if when the Motion, being either accelerated or retarded, is made in a Curve Line (as in the Vibrations of a Pendulum) the Impetus is to be estimated in each Point, according to both the Degree of Acceleration, and the Obliquity of the Tangent there. *Philosoph. Transact. N. 40.*

An Account of the Laws of Motion, in Bodies striking one against another, you have also from the famous Mr. *Hugens*, in *Philos. Transact. N. 46.*

Mr. John Keil, late of Baliol College in Oxon, in his Book called, *Introductio ad veram Physicam*, gives the following Theorems about the Quantity of Motion, and the Spaces passed over by the Moving Body, and which he there plainly demonstrates.

1. In comparing the Motions of Bodies, if the Quantity of Matter be the same, the Moments, or Quantities of Motion, will always be as the Velocities; and *vice versa*, if the Moments are as the Velocities, the Quantity of Matter in the Moving Bodies, is always the same.

2. If the Celerities are equal, the Moments, or Quantities of Motion, will be as the Quantities of Matter; or if the Moving Bodies are Homogeneous, as their Magnitudes.

And if the Moments are as the Quantities of Matter, the Velocities will be equal.

3. In comparing the Motions of any Bodies, the Ratio of the Moments is compounded of the Ratios of the Quantities of Matter, and the Celerities. See the Word *Moment*.



4. In comparing the Motions of any Moving Bodies, the *Ratio* of the Celerities is compounded of the *Ratio* of their Moments directly, and of their Quantity of Matter reciprocally.

5. If the Celerities of any Moving Bodies are equal, the Spaces passed over, will be directly as the Times in which the Motions are made.

And consequently, if the Times are as the Spaces, the Celerities must be equal.

6. If the Times are equal, the Spaces passed through, will be as the Velocities, and consequently, if the Spaces are as the Velocities, the Times will be equal.

7. The Distances, or Lengths run, are in a *Ratio* compounded of the *Ratio's* of the Times and Celerities; so that Spaces or Distances moved thro', may be consider'd as Rectangles, under the Times and the Celerities.

Wherefore if the Spaces, or Distances run, be equal, the Rectangle under the Celerity and Time of one Moveable, will be equal to that under the Celerity and Time of the other: And therefore, because equal Rectangles with unequal Sides, have their Sides reciprocally proportionable (14. *è* 6 *Euclid.*) as Celerity is to Celerity; so reciprocally shall Time be to Time; and consequently, when the Spaces are equal, the Times will be reciprocally as the Celerities.

8. The *Ratio* of the Times is always compounded of the *Ratio* of the Spaces passed over, directly, and of the Celerities reciprocally.

*The Incomparable Sir ISAAC NEWTON,*  
thus expresses these Two last Theorems.

When the Celerity is given, the Space passed through will be as the Time; and the Time being given, the Space is as the Celerity: Wherefore if neither be given, the Space will be as the Celerity and Time conjunctly.

When the Celerity is given, the Time is directly as the Space moved through; and the Space being given, the Time is reciprocally as the Celerity: Wherefore if neither be given, the Time is as the Space directly, and as the Celerity reciprocally.

Hence 'tis plain, the Motions of all Bodies are as the Rectangles under the Velocities, and the Quantities of Matter: wherefore the Matter and Celerity of Motion being given, the *Momentum* or Quantity of Motion is given: And if the *Moment* and *Matter* be given, the *Celerity* is given by dividing the *Moment* by the Quantity of *Matter*, *v.gr.* Let the Quantity of Matter be  $a$ , the Celerity  $c$ , and the *Moment*  $m$ : then will  $ca = m$ , and  $c = \frac{m}{a}$  and  $a = \frac{m}{c}$ .

Also since the Space passed over, or through, is always proportional to the Rectangle under the Velocity and the Time; let the Space be  $= S$ , the Time  $= T$ , and the Celerity as before  $= C$ . Then will  $S = CT$ , and  $C = \frac{S}{T}$  and  $T = \frac{S}{C}$ .

And Since also  $m = ac$ ,  $m$  will be equal to  $\frac{aS}{T}$ :

Or, if  $T$  be given,  $m = aS$ .

Hence also may be concluded, That if two Bodies are moved with equal Velocities, the *Moments* will be as the Quantity of Matter in each; and *vice versa*, the Quantity of Matter as the *Moments*: Wherefore if Bodies of equal Bulk are found to have unequal *Moments*, or Quantities of Motion, the Quantities of Matter must be unequal; and consequently, that which hath the least *Moment*, must have more of Pores or Vacuities interspersed than the other.

For Instance: If two Globes, one of Lead and the other of Cork, having equal Bulks, are moved with equal Swiftneſs; ſince the Quantity of Motion in the former, or its Force to move other Bodies, will be much greater than in the latter; it's plain there muſt be many more Pores or Vacuities in *this*, than in *that*.

### Mr. Varignon's Laws and Proportions about Motion.

1. In all kind of *Motions* whatever, *Rolling*, *Sliding*, *Uniform*, *Accelerated*, or *Retarded*, in Right Lines, or in Curves, &c. The Sum of the Forces which produce the Motion of all Parts of its Duration, is always proportionable to the Sum of the Paths, or Lines, which all the Points of the moving Body describe.

2. There is more Force required to make a Body Roll, or Revolve, (as ſuppoſe a truly Spherick Bowl on a mathematical Plane) than to make it Glide along with the ſame Celerity.

3. In all Gliding or Sliding Motions, whether *Uniform*, *Accelerated*, or *Retarded*, &c. The Force in the whole is always proportional to the Product of the Maſs (or quantity of Matter) multiplied by the Path or Line deſcribed by the Centre of Gravity of the moving Body.

4. The Product of the Duration of all Uniform Motions, multiplied by the Force which began the Motion, is always proportionable to the Product made by the Path, or Line of Motion multiplied by the Maſs or Quantity of Matter in the moving Body.

Let  $B, b.$  ſtand for the Body moved.  
 $M, m.$  for the Maſs or Quantity of Matter in it.  
 $S, s.$  for Space, or Diſtance moved through.  
 $T, t.$  for the Time in which the Motion is made.  
 $F, f.$  for the Force producing the Motion.  
 $C, c.$  for the Celerity of the Motion.

Then I ſay,  $F T : f t :: M S : m s.$  of any two Bodies in Motion. Then

$$\begin{aligned} 5. F : f :: M S t : m s T. \\ T : t :: M S f : m s F. \\ M : m :: F T s : f t S. \\ S : s :: F T m : f t M. \end{aligned}$$

6. If



6. If  $F = f$ , then shall

$$\begin{aligned} T : t &:: M S : m s. \\ M : m &:: T s : S t. \\ S : s &:: T m : M t. \end{aligned}$$

And reciprocally, Whenever  $T t$ ,  $M m$ ,  $S s$ , are in any of these Proportions, *Then are the Forces which move the Bodies equal*; which is the General Principle of all *Des Cartes's Staticks*.

7. If  $T = t$ , then shall

$$\begin{aligned} F : f &:: M S : m s \\ M : m &:: F s : f S \\ S : s &:: T m : t M \end{aligned}$$

And so reciprocally, If  $F$ ,  $M$ , or  $S$ , be in the Proportions, *The Times will be equal*. And from this may the Laws of all Machines be demonstrated after *Des Cartes's* manner.

8. If  $M = m$ , then will

$$\begin{aligned} F : f &:: S t : s T \\ S : s &:: F m : f M \\ T : t &:: S f : s F \end{aligned}$$

And reciprocally, If these Proportions be discovered, *Then the Masses are equal*.

9. If  $S = s$ , then will

$$\begin{aligned} F : f &:: M t : m T \\ M : m &:: F T : f t \\ T : t &:: M f : m F \end{aligned}$$

And reciprocally, If such Proportions are found, *The Spaces are equal*.

10. If  $F : f :: \begin{cases} M : m \\ S : s \end{cases}$

Then will

$$T : t :: \begin{cases} S : s \\ M : m \end{cases}$$

And reciprocally,

$$\text{If } T : t :: \begin{cases} S : s \\ M : m \end{cases}$$

Then will

$$F : f :: \begin{cases} M : m \\ S : s \end{cases}$$

11. If  $F : f :: T : t$ . Then

$$\begin{aligned} M : m &:: F F s : f f S :: T T s : t t S \\ S : s &:: F F m : f f M :: T T m : t t M \\ M S : m s &:: F F : f f :: T T : t t \end{aligned}$$

And reciprocally, If the Masses of the Bodies moved, or the Spaces run through, or the Products of the Masses, by the Spaces, (that is, the Quantity of Motion in the Bodies  $B$  and  $b$ ) are as in these Proportions, then are the Forces to one another as the Times.

And this observe also for a Principle to explain Machines and Engines, as above in Numbers 6 and 7.

12. If  $M : m :: S : s$ . Then

$$\begin{aligned} F : f &:: S S t : s s T :: M M t : m m T \\ T : t &:: S S f : s s F :: M M f : m m F \\ F T : f t &:: S S : s s :: M M : m m \end{aligned}$$

And Reciprocally, if the Forces, or the Times, or the Product of the Forces by the Times, are as in these Proportions; then the Masses are as the Spaces run thro'.

13. If  $F : f :: m : M$ . Then

$$\begin{aligned} T : t &:: M M S : m m s :: f f S : F F S. \\ S : s &:: m m T : M M t :: F F T : f f t. \\ T s : t S &:: M M : m m :: f f : F F. \end{aligned}$$

And Reciprocally, If the Times or the Spaces run thro', or the Products of the Times taken directly, by the Spaces taken Reciprocally, are as in these Proportions; then the Forces shall be to one another in a Reciprocal Ratio of the Masses.

14. If  $F : f :: s : S$ . Then

$$\begin{aligned} T : t &:: S S M : s s m :: f f M : s s m. \\ M : m &:: F F T : f f t :: s s T : S S t. \\ t M : T m &:: F F : f f :: s s : S S. \end{aligned}$$

And Reciprocally, If the Times, or the Masses, or the Products of the Masses taken directly, by the Times taken Reciprocally, are as in these Proportions; then the Forces shall be to one another in a Reciprocal Ratio of the Spaces run thro'.

15. If  $T : t :: m : M$ . Then

$$\begin{aligned} F : f &:: M M S : m m s :: t t S : T T s. \\ S : s &:: F m m : f M M :: F T T : f t t. \\ S t : s F &:: T T : t t :: m m : M M. \end{aligned}$$

And Reciprocally, If the moving Forces, or the Spaces run through, or the Product of the Spaces taken reciprocally by the Forces taken reciprocally, are as in these Proportions; the Time of the Motions will be to one another in a Reciprocal Ratio of the Masses of the Bodies moved.

16. If  $T : t :: s : S$ . Then

$$\begin{aligned} F : f &:: S S M : S S m :: t t M : T T m. \\ M : m &:: F s s : f S S :: F T T : f t t. \\ M f : m F &:: T T : t t :: s s : S S. \end{aligned}$$

And Reciprocally, If the moving Forces, or the Masses of the Bodies moved, or the Products of the Masses taken reciprocally, by the Forces taken reciprocally, are as in these Proportions; then the Times shall be to one another in a Reciprocal Ratio of the Spaces run thro'.

17. If  $F : f :: t : T$ . Then shall  
 $M : m :: s : S$ .

And Reciprocally,

If  $M : m :: s : S$ . Then will  
 $F : f :: t : T$ .

So that in all Engines, or Machines, having always  $T = t$ , you'll have Reciprocally  $F = f$ . viz. An Equilibrium where  $M : M :: s : S$ , which is the known Property of the Balance.

As



As to the Celerities, observe the following Rules.

18. In general.

$$C : c :: \frac{S}{T} : \frac{s}{t} :: S t : s T :: \frac{t}{s} : \frac{T}{S}.$$

19. Then also in the general.

$$\begin{aligned} T : t :: c S : C s. \\ S : s :: C T : c t. \\ F : f :: M C : m c. \\ M : m :: F c : f C. \\ C : c :: F m : f M. \end{aligned}$$

$$20. \text{ If } \begin{cases} F = f \\ M = m \\ T = t \\ S = s \end{cases}$$

Then shall

$$\begin{aligned} m : M \\ F : f \\ S : s \\ t : T \end{aligned} \left. \vphantom{\begin{aligned} m : M \\ F : f \\ S : s \\ t : T \end{aligned}} \right\} :: C : c.$$

And Reciprocally, If these Proportions are true; the preceeding Equalities are so also.

And the Equilibrium will be found always in every Machine, where it is made; as  $m : M :: C : c$ . And this is that which *Galileus* took for the First Principle of *Statics*. (See *Syst. Cosm. Dialog. 2. Pag. 298, &c.*

$$21. \text{ If } \begin{cases} M : m \\ T : t \\ f : F \\ s : S \end{cases} :: C : c.$$

Then

$$\begin{aligned} F : f :: C C : c c. \\ S : s :: T T : t t. \\ M : m :: c c : C C. \\ T : t :: S S : s s. \end{aligned}$$

And Reciprocally, If these last Propositions are true, the first are so also.

$$22. \text{ If } \begin{cases} F : f :: M : m \\ \text{or,} \\ T : t :: S : s \end{cases} \text{ Then will } C = c.$$

Or,

$$\text{If } C = c : \text{ Then shall } \begin{cases} F : f :: M : m \\ \text{And} \\ T : t :: S : s \end{cases}$$

$$23. \text{ If } \begin{cases} F : f :: S : s \\ \text{Or,} \\ M : m :: T : t \end{cases}$$

Then will

$$\begin{aligned} C : c :: S m : M S :: F t : f T. \\ M : m :: S c : s C. \\ T : t :: F c : f C. \\ S : s :: M C : m c. \\ F : f :: T C : t c. \end{aligned}$$

And Reciprocally, If these last Proportions are true, the first are so also.

24. If  $F : f :: T : t$ . Then shall

$$\begin{aligned} C : c :: m T : M t. \\ T : t :: M C : m c. \\ M : m :: T c : t C. \end{aligned}$$

And Reciprocally, If the Celerity, or the Masses, or the Times, or the Forces, are as in these Proportions, then the Forces shall be to one another as the Times; which was the Principle of *Galileus*, mentioned before in Number 20.

25. If  $M : m :: S : s$ . Then shall

$$\begin{aligned} C : c :: F s : f S. \\ F : f :: S C : s c. \\ S : s :: F c : f C. \end{aligned}$$

And Reciprocally, If the Celerities, or the Forces, or the Masses, or the Spaces run thro', are as in these Proportions; then the Masses of the Bodies moved, are to one another as the Spaces run thro'.

$$26. \text{ If } F : f :: m :: M. \text{ Then } C : c :: \begin{cases} m m : M M \\ F F : f f \end{cases}$$

And Reciprocally, If these last Proportions are true, the first must be so also.

$$27. \text{ If } T : t :: s : S. \text{ Then } C : c :: \begin{cases} S S : s s \\ t t : T T \end{cases}$$

And Reciprocally,

$$\text{If } C : c :: \begin{cases} S S : s s \\ t t : T T \end{cases} \text{ Then shall } T : t :: s : S.$$

28. If  $F : f :: s : S$ . Then

$$\begin{aligned} C : c :: s m : S M. \\ M : m :: c s : C S. \\ s : S :: C M : c m. \end{aligned}$$

And Reciprocally, If the Celerities or the Masses, or the Forces, or the Spaces, are as in the last Proportions; then the Forces shall be Reciprocally as the Spaces.

29. If  $T : t :: m : M$ . Then

$$\begin{aligned} C : c :: F T : f t. \\ F : f :: t C : T c. \\ T : t :: f C : F c. \end{aligned}$$

And Reciprocally, If the Celerity, or the Forces, or the Times, or the Masses, are as in the last Proportion; then the Times shall be to one another in a Reciprocal Ratio of the Masses.

$$30. \text{ If } \begin{cases} F : f :: t : T. \\ \text{Or,} \\ M : m :: s : S. \end{cases} \text{ Then}$$

$$\begin{aligned} C : c :: F S : f s :: t m : M T. \\ F : f :: s C : S c. \\ t : T :: M C : m c. \\ M : m :: t c : T C. \\ s : S :: F C : f C. \end{aligned}$$



And Reciprocally, If the Celerities, Forces, Times, Masses, or Spaces run thro', are in the last Proportions; then the Masses shall be in a Reciprocal *Ratio* of the Spaces, and the Forces Reciprocally as the Times: Which is also the same that Dr. *Cartez* took for his first Principle of *Statics*. See the *Memoirs de la Mathematique & de la Physique*.

**MOTION:** From the first of Sir *Is. Newton's* three Laws of Motion or Nature mentioned under this Word Motion by way of *Corollary* may be inferred, (1.) That no Particle of Matter, or any Combination of such (that is, no Body whatever) can either move of it self, or alter the Direction of its Motion, because 'tis entirely passive and indifferent as to Motion or Rest; so that neither Motion or Rest are essential to Matter. (2.) 'Tis plain also from hence, that naturally of it self, no Body can ever move in a Curve Line; for since all Motion is originally and naturally rectilinear, 'tis impossible that any Body can move in a Curve or Line that is not strait of itself; because then it must of it self continually alter the Direction of its Motion, which cannot be, by the former *Corollary*; wherefore the Motion of the Heavenly Bodies in Circles or Ellipses cannot be accounted for by the natural Laws of Motion; but it is owing to the Will of the great Creator that they are kept in their Orbits by an attractive Force.

From the second of the three Laws of Motion, it follows, that all Effects will always be proportional to their *Adequate Causes*; and thus if any Degree of any Force will produce any Degree of Motion, a double Degree of the same Force will produce a double Degree of Motion, a Triple, a Triple, and so on in any Ratio whatsoever. And this Motion must proceed on in the same Direction with that of the moving Force, because 'tis from *That* only that the Motion arises; and Bodies once in Motion, cannot change their Direction of themselves.

And if a Body be already in Motion, the Motion arising from a Force impress'd, if it be in the same Direction with that of the former Motion, it will increase it in Proportion to its Power; but if it be impress'd in a contrary Direction, it destroys the former Motion either totally or in part, that is, equal to the Force of the Impression. And when it hath a Direction any way oblique to that of the former Motion, it is either added to, or subtracted from it, according as a Motion arising from a Composition of those two, is determined.

### Of Equable MOTION.

#### DEFINITION.

By Equal, Equable, or Uniform Motion, I mean that whose Celerity or Swiftness, neither Increases nor Decreases in each Space of Time or Place; that is, which is neither swifter or slower in the first Yard or Mile it passes, than in the second; or in the first Minute or Hour of its Progress, than in the second, &c.

#### PROP. I.

If a Mobile moved Equably pass over two Spaces with the same Velocity, the Times of the Motion shall be to each other as the Spaces perform'd.

#### INSTANCE I.

If any Horse run equably Swift, he is twice as long running over two Miles as one Mile.

#### INSTANCE II.

The Hand of a true going Clock or Watch, is supposed to move Equably, and it is twice as long passing two Divisions as one Division.

#### PROP. II.

If one equable Mobile pass over in equal times, with unequal Velocities two Spaces, the Spaces shall be as the Velocities, and if the Spaces be as the Velocities, the Times shall be equal.

*1st*, Instance of the former Part of the Proposition, which more plainly for our purpose, may be pronounced thus. *If two equable Mobiles pass over in an equal Time two Spaces, the Spaces shall be as the Velocities.*

Thus if there be two Horses, one twice as swift as the other, and the swifter run a Mile in a Minute, the slower shall run in the same Minute but half a Mile.

*2d*, Instance of the latter Part of the Proposition, I say likewise, that the swifter runs a Mile, and the slower half a Mile, in the same Quantity of Time. And this indeed is but a Conversion of the former part of the Proposition.

#### PROP. III.

The Times of Motions through the same Space with unequal Velocities are in a reciprocal Ratio of their Velocities.

#### INSTANCE.

If there be two Horses A twice Swifter than B, is running a Mile, twice as long time as A, that is, the Velocity of A is to the Velocity of B as 2 to 1, therefore the Time of B is to the Time of A as 2 to 1.

#### PROP. IV.

If two Mobiles be moved equably, but with unequal Velocity, the Spaces passed by them in unequal Times, shall have a Ratio to each other compounded of the Ratio of the Velocities, and of the Ratio of the Times.

#### INSTANCE.

If there be two Horses A, twice swifter than B, and A run four Miles in six Minutes, B in three Minutes shall run but one Mile; for if B run as swift as A, and A in six Minutes run four Miles, then B in three Minutes would run two Miles; but by Supposition, A runs twice swifter than B, therefore B in three Minutes runs but 1 Mile. Now it's manifest, the Ratio of the Velocity of A to the Velocity of B, is as 2 to 1, also the Ratio of the Time of A's running, to the Time of B's running, is as 2 to 1; then compounding these two Ratio's, we have the Ratio of 4 to 1, that is, the Ratio of the Spaces passed four Miles



Miles by A the Swifter, and 1 Mile by B the Slower.

## P R O P. V.

If two Mobiles be moved Equally, and their Velocities be unequal, and the Spaces they pass unequal, the Ratio of their Times shall be compounded of the Ratio of the Spaces, and of the Ratio of their Velocities *contrarily* taken.

## I N S T A N C E.

If there be two Horses, A twice as swift as B, if A be running four Miles six Minutes, B shall be running 1 Mile three Minutes. For the Ratio of A's Space to B's Space, is 4 to 1. Also the Ratio of B's Velocity to A's Velocity (because their Velocities are to be *contrarily* taken) is as 1 to 2. Then compounding the Ratio of 4 to 1 and of 1 to 2, we have the Ratio of 4 to 2 or double, that is, the Ratio of the Times A being six Minutes, and B three Minutes.

## P R O P. VI.

If two Mobiles be moved equally, the Ratio of their Velocities shall be compounded of the Ratio of the Spaces passed, and the Ratio of the *contrarily* taken Times.

## I N S T A N C E.

If there be two Horses A and B, and if A run four Miles in six Minutes, and B run one Mile in three Minutes, I say A's swiftness is to B's as 2 to 1; that is, A is twice swifter than B, for the Ratio of A's Space four Miles to B's one Mile, is as 4 to 1; also the Ratio of B's time to A's time (because of the Words *contrarily taken Times*) is as 1 to 2. Then compounding the Ratio of 4 to 1, with the Ratio of 1 to 2, we get the Ratio of 4 to 2; that is, A's Velocity or Swiftness is double B's Swiftness.

And thus have I cleared the six Propositions of *Galileo* relating to equable Motion, which though apparently mean and poor, yet are they the Foundation of a vast Structure of a Doctrine no less useful than pleasant, and of advantage to the General and Soldier in the Field, as delightful to the thoughtful Contemplator in his Closet. And here let it not be objected, that I have made my Horses run equally, that is, neither faster nor slower at the Beginning than at the End of their Course; for though I know this is contrary to Experience, yet surely the liberty of *supposing* this for Illustration sake will not be denied me. All I designed was to make the foregoing Propositions plain and obvious to the common Capacities, without troubling them with intricate Demonstrations. I have only to add, that this Doctrine of compounded Reasons may be learned from *Euclid*, and his Commentators, on the five Definitions of the sixth Book; or briefly this, if the Ratio of A to B were given to be compounded with the Ratio of B to C, Fractions expressing Ratios, set them fraction-wise thus,  $\frac{A}{B} \frac{B}{C}$ , then Multiply the Numerators together for a new Numerator, and the Denominators together for a new Denominator, and we

have  $\frac{A}{B} \frac{B}{C}$  or  $\frac{A}{C}$  the Composition of this two Ratio's, that the Ratio of A to B being compounded with the Ratio of B to C, there results the Ratio of A to C. Thus in Numbers the Ratio of 6 to 4, being compounded with the Ratio of 3 to 7, there results the Ratio of 18 to 28 or 9 to 14. If any one desires the Mathematical Demonstrations of the foregoing Propositions, they may have Recourse to *Galileo* in his *Discorsi e Dimostrazioni Matematiche*, &c. Printed amongst his Works at *Bononia*, 1655. 4<sup>to</sup>.

MOTION of the *Apogee*, in the *Ptolemaick* System, is an Ark of the *Zodiack* of the *Primum Mobile*, contained between the Line of the *Apogee* and the Beginning of *Aries*.

MOTION Compounded. See *Composition of Motion*.

Natural MOTION [in *Mechanicks*] is that whose Principle of moving Force is within the moving Body, as that of a Stone falling to the Centre of the Earth.

Violent MOTION is that whose Principle is external or without, and against which the moving Body makes a Resistance, as that of a Stone thrown upwards.

Absolute MOTION is the Change of Place in any moving Body, the Celerity of which therefore will be measured by the Quantity of the absolute Space which the moveable Body runs through.

Relative MOTION is the Mutation of the Relative or vulgar Place of the moving Body, and the Celerity of it is accounted by the Quantity of relative Space run through.

Proper MOTION is the removal of a Body out of one proper Place into another, that becomes proper, as being possessed by this Body alone, in exclusion of all others, as the Motion of a Wheel in a Clock.

Improper MOTION, } is the Passage of a  
Extraneous MOTION, } Body out of one  
Common MOTION, } common Place into  
another common Place; as that of a Clock when mov'd in a Ship, &c.

Simple MOTION is that which is produced by some one Power.

Perpetual MOTION, the celebrated Problem of a perpetual Motion consists in the Invention of a Machine, which has the Principle of its Motion within itself.

Animal MOTION is that whereby the Situation, Figure, Magnitude, &c. of the Parts, Members, &c. of Animals are altered or changed, and is either *spontaneous* or *natural*.

Spontaneous MOTION is muscular Motion, being performed by means of the Muscles at the Command of the Will, and thence is call'd *voluntary Motion*.

Natural MOTION is that which is effected by the mere Mechanism of the Parts, without the Command of the Will, thence call'd *involuntary Motion*, as the Motion of the Pulse, Heart, the peristaltick Motion of the Intestines.

Intestine MOTION is the Agitation of the Particles of which a Body consists.

MOTION [in *Astronomy*] is a Term apply'd to the ordinary Courses of the Heavenly Bodies, as the Earth from *East* to *West*, and the Motions of the Celestial Luminaries are *diurnal* and *secondary*.



*Diurnal* MOTION [in *Astronomy*] is that wherewith all the heavenly Bodies and the whole mundane Sphere appears to revolve round the Earth daily from *East* to *West*; this is also call'd *common Motion* or the Motion of the *Primum Mobile* in distinction to that of each Planet.

*Secondary* MOTION [*Astronomy*] is that whereby a Star, Planet or the like advances a certain Space every Day from *West* to *East*. This is call'd also *Proper Motion*.

MOTION [in *Musick*,] is the Manner of beating the Measure to hasten or retard the Time of the Pronunciation of the Words or Notes.

MOTIONS [in the *Military Art*] are the marches and counter-marches that an Army makes in changing its Post.

MOTORII [in *Anatomy*] the third pair of Nerves which serve for the Motion of the Eye. They are united into one near their insertion into the Brain, by which means when one Eye is moved towards any Object, the other is directed towards the same.

MOTOS [in *Surgery*] a piece of Lint or Linen Cloth teaz'd like Wool to be put into Ulcers to stop the Flux of Blood, &c.

MOTRIX *Vis*. See *Vis Motrix*.

MOVEABLE Feasts, are those Festivals which, tho' they are Celebrated on the same Day of the Week, have no Fixed Seat in the Calendar, but in several Years happen on several Days of the Month; of which kind are *Easter* and *Whitsontide*; &c.

MOVEMENT, the same with what many do call an *Automaton*, and with us signifies all those Parts of a Watch, Clock, or any such Curious Engine which are in *Motion*, and which by that Motion carry on the Design, or answer the End of the Instrument.

The Numbers of the *Wheels*, *Pinions*, *Notches*, &c. in any Piece of Clock or Watch-work, are usually thus written or express'd:

Where the uppermost Number above the Line is the Pinion of the Report 4, the Dial-wheel 36, and 9 the Turns of the Pinion of Report. The second Number (under the Line) is 5 the Pinion, 55 is the great Wheel, and 11 the Turns of the Pinion it driveth. The third Numbers are the second Wheel, &c. The fourth the Contrate-wheel, &c. And the single Number 17, under all, is the Crown-wheel.	4) 36 (9 ————— 5) 55 (11 5) 45 (9 5) 40 (8 ————— 17
--	---

These Numbers, by some, are also express'd Fraction-wise, thus,  $\frac{3}{4}$ ,  $\frac{5}{2}$ ,  $\frac{4}{5}$ ,  $\frac{4}{5}$ , 17 Notches in the Crown-wheel.

MOULDINGS [in *Architecture*] Ornaments, Projectures beyond the Naked of a Wall, Column, Wainscot, &c. the Assemblage of which forms Cornishes, Doors, Cases, &c.

MOULINET, a *French* Term, signifying a *Turn-stile*: 'Tis used in Mechanicks, and signifies a *Roller*, which being cross'd with two *Levers*, is usually applied to *Cranes*, *Capstans*, and other sort of Engines of the like Nature, to draw Cords, and heave up Stones, Timber, &c. Also a kind of Turn-stile or Wooden Cross, which turns horizontally upon a Stake fix'd in the Ground; and is usually placed in Passages, to keep out Horses, and to oblige Passengers to go or come one by one.

These *Moulinets* are often set up near the Out-works of Fortified Places, at the side of the Barriers, through which People pass on Foot.

MOUND. The Term in Heraldry for a Ball or Globe, with a Cross upon it, such as our Prin-

ces are usually drawn or painted with, holding it in their Left Hand, as they do the Sceptre in their Right. *Mound* also signifies a Fence or Hedge.

MOUNT-EGG; after Tin from the burnt Ore is melted down and remelted, there will sometimes remain a different Slugg in the Bottom of the Float, this they call *Mount-Egg*; and tho' of a Tin Colour, yet is of an Iron Nature, as hath been found by applying a *Magnet* to it.

MOYENAU (a *French* Term) in Fortification, is a small flat Bastion, commonly placed in the middle of an over-long Curtain, by which the Bastions at the Extremities are not well defended from the Small-shot, by reason of their Distance; so that this Work is proper for placing in it a Body of Musqueteers to fire upon the Enemy from all sides.

MUCILAGE, in Pharmacy, is a viscous Extraction made of Seeds, Gums, Roots, &c. with Water.

MUCILAGINOUS Glands, are a numerous sort of Glands seated in the Joints, first, I think, particularly taken Notice of by Dr. *Havers*, in his *Osteologia*: He saith, these are of two sorts, some are small, and in a manner miliary Glands, being Glandules placed all upon the same Surface of the Membrane, which lies over the Articulations. The other sort are conglomerated, or many Glandules collected and planted one upon another, so as to make a Bulk, and appear conspicuously, and are considerable Glands. In some of the Joints there are several of them; in others there is a single Gland.

For the Structure of these large Glands, they consist of small Vesicles, which are not gathered into several Lobules or Bags of Glandules, but are disposed upon several Membranes lying one over another; of which Membranes there are several in every one of these Glands, which appear evidently in them that are Hydropical.

They have their Blood-Vessels; as other Glands, but their Veins have a particular Flexure in their Course for retarding the Return of the Blood from the Glands, that the mucilaginous Liquor, which is not separated with the greatest Expedition, may have Time to penetrate the secretory Pores of the Glandules.

The large Mucilaginous Glands are variously seated; some in a *Sinus*, formed in the Joint; others stand near or over-against the Interstice, between the Articulated Bones; but in general they are so placed, as to be squeez'd gently, and lightly press'd in the Inflexion or Extension of the Joint, so as to separate a Quantity of Mucilage proportionate to the Motion of the Part, and the present Occasion, and yet without any Injury.

The Design of all these Glands is to separate a mucilaginous kind of Liquor that serves principally to lubricate the Joints, to make them so slippery as to be moved with the greatest Facility imaginable. It serves likewise to preserve the Ends of the Articulated Bones from Attrition, and an immoderate Incalescence. But all these Things it performs in Conjunction with the medullary Oyl: of which two Ingredients, is made a Composition admirably fitted for these Ends: For the Mucilage adds to the Lubricity of the Oyl, and the Oyl preserves the Mucilage from growing too thick and viscous.

The Doctor observes the same sort of Glands to lie between the Muscles and Tendons, and supposes that there is the same Mixture of an Oily and Mucilaginous Substance; the one being that Fat which



which is found between the Muscles, and is supply'd by the Adipose Glands; the other being separated by the mucilaginous Glandules, of which the common Membrane of the Muscles is every where full. This Mixture in the Interstices of the Muscles, lubricates them and their Tendons, and preserves them from shrinking, and from growing dry and hard.

For the Generation of this Mucilage, he supposes that Nature has designed one large *Viscus*, and that this is the Office of the Spleen; the Glandules of which he makes to have two secretory Pores; by one of which some Acid, and by the other, some Austere Particles are separated; which meeting in the small Cavities of the Glandules, they are converted into a Mucilaginous and Gummous Substance; he having observed, that Spirit of Vitriol mix'd with a Decoction of Galls, will produce a Gum.

After this, he gives an Account of Experiments made with the Mucilage; the most of which come to this, That all Acids do coagulate it, as all Austeres and Austere Acids; but with this Difference, that the *Coagulum* or Curd made by Acids only, is tenderer than that which is produced by an Austere only, or an Austere Acid.

MUCOUS Glands [in *Anatomy*] are three Glands which empty themselves into the *Urethra*, so called from the Tenacity of the Liquor which they separate.

MUCRO *Cordis*, or *Apex*, is the lower pointed End of the Heart.

MUCRONATED, is whatever ends or terminates in a Point, like that of a Sword, &c.

MUCKONATUM *Os*: See *Ensisformis Cartilago*.

MUCUS of the *Joints* [in *Medicine*] a mucilaginous Liquor separated by its proper Glands, conveniently placed in the Interstices of the Bones, where those Glands are gently press'd by the Motion of the Parts; serving to make the Extremity of the Joints or Bones slip more easily. L.

MUCUS of the *Urethra* [in *Medicine*] is a viscous transparent Liquor, which serves to line and lubricate the Parts, that the *Semen* may slip more easily without adhering.

MUCUS of the *Nostrils* [in *Medicine*] is a Mucus separated by its proper Glands, placed in the internal Membrane of those Parts; serving to moisten, lubricate and defend the Olfactory Nerves, which being very soft and naked would be soon spoil'd without such a Provision.

MUD-SUCKERS, *Limifugæ*, are a sort of Water-Fowl which suck out of the Mud of Channels, &c. some oily Juice or Slime with which they are nourished; hence they are always delicate Flesh, and their very Guts uncleaned from the Excrements are usually eaten, as those of *Woodcocks*, &c. These *Mudsuckers* have therefore very long Bills, and broad near the Tip.

MUFFLE, in Chymistry, is the Cover of a *Test* or *Coppel*, which is put over it in the Fire.

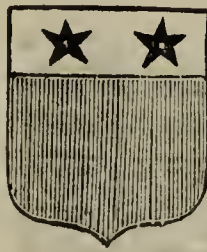
MULIER, a Term used in our Common Law; some think it to be a Corruption either from the Latin *Melior*, or the French *Meilleur*, and signifies the *Lawful Issue* preferred before an elder Brother born out of Matrimony. Others will have it to be derived, *quasi ex muliere natus & non ex concubina*; and so they use the Word *Filius mulieratus*, in Opposition to a Bastard; and in this Sense the *Scotch* also use the Word, and therefore this last Etymology is most probable.

VOL. II.

MULLET, the Term in Heraldry for a Star of Five Points, of this Figure; and is usually the Difference or Distinguishing Mark for the Third Brother, or House.



Though 'tis often also born as Coat-Armour; as here:



Ruby on a Chief Pearl, Two Mullets Diamond; being the Coat of the Famous Lord *Verulam*, first Sir *Francis Bacon*. The *Heralds* say, the *Mullet* represents a *Falling-Star*; 'tis rarely born of Six Points.

MULTA, or *Multura Episcopi*, was a Fine given to the King, that the Bishop might have Power to make his Last Will and Testament, and to have the Probate of other Mens, and the granting Administrations.

MULTANGULAR Figure, is one that has many Sides and Angles.

For its Superficial Content, see *Area*.

MULTILATERAL, in Geometry, are those Figures that have more than Four Sides.

MULTINOMIAL Root: See *Polynomial*.

MULTIPLE Proportion, is when the Antecedent being divided by the Consequent, the Quotient is more than Unity: And the Reason of the Name is, because the Consequent must be multiplied by the Index, or Exponent of the Ratio; to make it equal to the Antecedent. Thus 12 is multiple in proportion to 4, because, being divided by 4, the Quotient is 3, which is the Denominator of the Ratio: And the Consequent 4 being multiplied by 3, makes the Antecedent 12; wherefore 3 is *Sub-multiple* of 12.

MULTIPLE *Super-particular Proportion*, is when one Number or Quantity contains another more than once, and such an Aliquot Part more; of which see more under *Proportion*.

MULTIPLE *Super-partient Proportion*, is when one Number or Quantity contains another divers times, and some Parts thereof besides.

MULTIPLICATION, is, in general, the taking or repeating of one Number or Quantity as often as there are supposed Unities in the other. The Number *multiplied*, is called the *Multiplacand*; the Number *multiplying*, the *Multiplicator*; and that which is found or produced, is called the *Product*.

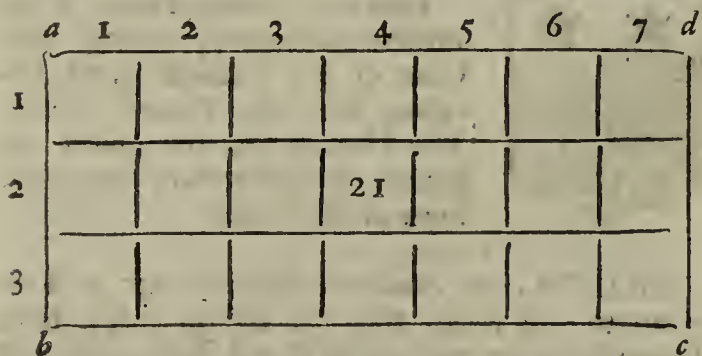
*Multiplication* is only a *Compendious Addition*, effecting at once what in the ordinary way of *Addition* would require many Operations: For the *Multiplacand* is only added to it self, or repeated, as often as the Unities of the *Multiplicator* do express. Thus if 6 were to be multiplied by 4, the *Product* is 24, which is the Sum arising from the *Addition* of 6 four times to it self.



In all *Multiplication*, as 1 is to the *Multiplicator*, so is the *Multiplicand* to the *Product*. Whence 'tis plain, that in *Multiplication* of *Integers*, the *Product* must be greater than either of the *Factors*, (for so the *Multiplicator* and *Multiplicand* are called, because between them they make up the *Product*) because either *Factor* is greater than *Unity*. But in *Multiplication* of *Fractions*, the *Product* must be less in Value than either of the *Factors*, because they are both less than *Unity*. Thus 24, the *Product* of 6, multiplied by 4, is greater than either 6 or 4; but  $\frac{1}{2} \times \frac{3}{4}$ , the *Product* of  $\frac{3}{4}$ , multiplied by  $\frac{1}{2}$  is less in Value than either  $\frac{3}{4}$  or  $\frac{1}{2}$ .

**MULTIPLICATION** in Geometry, or in Lines,

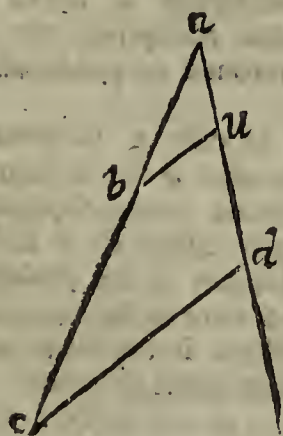
Is made by supposing a Right Line, as  $a b$ , to be moved in a perpendicular Posture along another, as  $b c$ ; in which Case, the Line  $a b$  is



called the *Describent*, and  $b c$  the *Dirigent*. For by this means the *Describent*  $a b$ , will form the Rectangle  $a d c b$ ; and if it be divided, together with the *Dirigent*, into any Number of equal Parts, it will by its Motion describe as many little Rectangles, as the *Unites* in the *Describent* and *Dirigent* will produce, by being multiplied into one another, viz. 21. For when the Line  $a b$  hath moved over one part of  $a d$ , it will, by its 3 Parts, have described the 3 little Rectangles in the first Column; when it comes to 2, it will have described 3 more, &c.

And this is the Reason why *Multiplication*, in the *Latin* Tongue, is usually expressed by the Word *Ducta*; (and from hence also comes *Product*) as if  $a b$  were multiplied by  $b c$ ; they say  $a b$  ducta in  $b c$ ; because the *Describent* is led, as it were, or carried along in an erect Posture upon the *Dirigent*, and by that means describes the Rectangle: So that Rectangle and *Product* are all one in Geometry.

Since in all *Multiplication*, *Unity* is to one *Factor*, as the other is to the *Product*: therefore *Multiplication* in Lines may be performed Geometrically thus:



Let  $a b$  be to be multiply'd by  $a d$ , make any Angle at pleasure, and then on one of the Legs set off  $u =$  to *Unity*; and on the same Leg set off  $u d$ , the *Multiplicator* (3). Then set the *Multiplicand*  $a b$  (2) from  $a$  on the other Leg of the Angle; draw  $u b$ , and parallel to it, through  $d$ , draw  $d c$ . I say,  $d c$ , or 6, is the *Product*: For  $a u : u d :: a b : b c$ .

**MULTIPLICATION**: It often happens that 'tis needless to express at large all the Figures of the *Product*, especially where the *Factors* have each many Places of *Decimal* Parts; and therefore the following Compendium is as useful as 'tis curious.

Suppose 3.141592 were to be multiplied by 52.7438; and that a *Product* which should have 4 Places of *Decimals*, would be enough for the present Purpose. First write down the *Multiplicand*, and set the Place of *Unites* in the *Multiplicand*, under that Figure of the *Multiplicand*, whose Place you intend to keep in the *Product*. Thus let 3.141592 be the *Multiplicand*, and you would have but 4 Places of *Decimals* in the *Product*; place therefore 2, the Place of *Unites* in the *Multiplicand*, under 5 the 4th Place of *Decimals* in the *Multiplicand*. Thus,

	3.141592
	8347.25
After this place all the other Figures of the Multiplier in a contrary Order; viz.	1570796
the 5 Tens in 52 to the Right-hand in the Place of Unites, and all the Decimal Parts to the Left-hand, as you see in the Example. Then in multiplying begin always at the Figure in the Multiplicand that stands over the Figure you multiply by; setting down the first Figure of each particular Product, directly underneath one another, only you must have Regard to the Increase which would have arisen out of the multiplication of the two next Figures, which stand to the Right Hand of that Figure in the Multiplicand, which you begin with.	62832
	21991
	1257
	94
	25
	165.6995

The *Product* with 4 places of *Decimals* only.

Thus, say 5 times 9 is 45, and one which would arise from 5 multiplying 2, makes 46; therefore write down 6 and go on as in common *Multiplication*.

Then with the next Figure 2, say twice 5 is 10; which with the Increase that would arise from 2 multiplying 9, will be nearly two Tens to be put down instead of the Cypher. Then say, twice 1 is 2, and one to be added from the twice 5 is 3; therefore write down 3, and go on as usually.

Next go on with 7, and say, 7 times 1 is 7, but from the Consideration of 7 being multiplied into the two Figures 5 and 9, which stand to the Right Hand of the 1, there will be 4 to be added; so 7 and 4 make 11, write down 1 and carry 1, &c.

Another Example will make all plain.

Let 257.356 be to be multiplied by 76.48, and the *Product* to be entirely consisting of *Integers* without *Decimal* Parts.

First



First write down the Multiplicand, and then set 6, the Place of Units, in the Multiplier under 7 the Place of Units in the Multiplicand (because you are to have no Decimal Parts) and write down the other Figures in a contrary Order, as above directed; proceeding also with each single Figure, as is there taught.

$$\begin{array}{r} 257.356 \\ 84.67 \\ \hline 18015 \\ 1544 \\ 103 \\ 20 \\ \hline 19682 \end{array}$$

The Product clear of Fractions.

## MULTIPLICATION in Algebra or Species.

The General Rule is, To conjoin the Quantities proposed by the Sign ( $\times$ ); which Sign, when the Quantities to be multiplied are express'd by but one or two Letters, is usually omitted, and the Quantities written down like Letters in a Word. Thus  $a e$  multiplied by  $b d$ , may be written  $a e \times b d$ , or, as is most usual,  $a e b d$ .

And if the Signs  $+$  or  $-$ , prefixed before the Quantities to be multiplied, are like, the Product is  $+$ ; if unlike, the Product is  $-$ .

N. B. In Algebraick Multiplication, 'tis most commodious to begin to multiply at the Left-Hand, because we write that Way.

## Particular RULES.

### I. RULE.

When two or more single Quantities, express'd by Letters, whether like or unlike, are to be multiplied into one another, and have no Numbers prefix'd; join the Quantities together, like Letters in a Word, and 'tis done:

$$\begin{array}{r} \text{Thus, } \frac{d}{f} \text{ and } \frac{ab}{dc} \text{ and } \frac{mno}{pqr} \\ \hline \text{Product} = \frac{df}{1} \frac{abcd}{1} \frac{mnopqr}{1} \end{array}$$

### II. RULE.

If two simple Quantities, whether like or unlike, are to be multiply'd, having Numbers or Co-efficients prefix'd before them; first multiply the Co-efficients one into another, and to the Product annex the Letters of both Quantities; so this new Quantity is the Product sought.

Thus  $3 a$  multiplied by  $4 b$ , produces  $12 a b$ .

### III. RULE.

The Multiplication of Compound Quantities, depends on the preceding Rules: For every Member of the one, must be multiplied into every Member of the other; respect being had to the Signs, by the Caution given in the General Rule.

$$\text{Thus, } \frac{a}{g} \frac{d-c}{b+f}$$

$$ag + gd - gc - ba + bc - bd \times fa + fd - fc$$

### IV. RULE.

Sometimes, when Compound Quantities are to be multiplied one by another, it is commodious to omit the Operation, and to set only the Word (*into*) or ( $\times$ ) between them; having first drawn a Line over each Compound Quantity, to shew that every Member of the One is to be multiplied by every Member of the Other.

Thus, To multiply  $aaa + 3aa - 2aa + 1$  by  $aa - 5a + 6$ ,

Write  $aaa + 3aa - 2aa + 1 \times$  or into  $aa - 5a + 6$ .

That in Algebraic Multiplication Like Signs give  $+$ , and Unlike  $-$ , in the Product, may be thus demonstrated:

1. Since Multiplication is the same thing as adding one Factor to it self, or repeating it so oft as there are Unites in the other.

2. Therefore,  $+$  multiplying  $+$ , must produce  $+$ , since Positives added, will produce a Positive Sum.

3. A Positive multiplying a Negative, must produce a Negative: For 'tis only adding the Negative Factor to it self, or repeating it so often as there are Unites in the other. Now many Defects added, must still be Defects, or must have a Negative Sign, thus:

$- 6$  multiplied  $+$   $2$ , produces  $- 12$ .

4. Negatives multiplying Positives, must produce Negatives: For when the Multiplier is defective, (there being really no Unites in it) it must work on the Multiplicand by Subtraction; therefore, in this Case, the Multiplicand must be subtracted (or made Negative) as often as there are Negative Unites in the Multiplier: But to take away Positives, is to add Negatives; therefore the Defect of the Multiplicand is to be added or repeated as often as the Case requires; and if so, the Product must be Negative (by the last) thus:

$+$   $6$  multiplied by  $- 2$ , gives  $- 12$  in the Product.

5. Negatives multiplying Negatives, must produce Positives: For since Multiplication by a Negative is the same as Subtraction; and subtracting a Defect or Negative, the same as adding Positives, therefore 'tis clear, the Defect of the Multiplicand must be subtracted (that is, the Positive Multiplier added) so often as there are seeming Unites in the Multiplier; which must needs produce Positive, thus:

$- 6$  into  $- 2$ , produces  $+$   $12$

MULTIPLICATION of Integers, in Common Arithmetick, is performed thus:



Suppose 365, the Days in a Year, were to be multiplied by 24, the Hours in a Natural Day; write down the *Multiplicator* orderly under the *Multiplicand*, Unites being under Unites, Tens under Tens, &c. as you see here, and draw a Line under them. Then say, 4 times 5 is 20; I set down 0, and carry two Tens to the next Rank; therefore 4 times 6 is 24, and 2 I carried is 26: I set down 6, and carry 2 (that is 200) to the next Rank. Then I say, 4 times 3 is 12, and 2 I carried make 14; (*i. e.* 1400) which 14, because I have now done with the first Figure 4, I set down as you see. Then I begin with 2, the second Figure of the *Multiplicator*, which stands in the Place of Tens, and say, twice 5 is 10; I set down 0 under 6 (which is under 2, the Figure that I multiplied by, for that Rule must always be observed) and carry 1. Then twice 6 is 12, and 1 I carried is 13; I set down 3 on the Left-Hand of the last, and carry 1, as before. Lastly, I say, twice 3 is 6, and 1 I carried makes 7; which 7 I set down, as you see. Then adding the two Products, thus found, together, you will have 8760 for the true Product.

N. B. When there are Cyphers at the End of either Factor, or after both, multiply the significant Figures one into another, and to the Right Hand affix as many Cyphers as were in both; *v. gr.*

$$\begin{array}{r} 466000 \\ 4000 \\ \hline 1864000000 \end{array}$$

When Cyphers are intermixed with the significant Figures of the *Multiplicator*, the Operation of them, may commodiously be omitted, regard being had to the due placing the Figures of the Product, as you see in this

Example.

$$\begin{array}{r} 26845 \\ 3004 \\ \hline 107380 \\ 80535 \\ \hline 80642380 \end{array}$$

The Proof of Multiplication can only certainly be effected by Division, the Common Method by casting out the Nines, being false: For if you divide the Product by either Factor, the Quotient, if you have wrought truly, will be the other; for Division destroys what Multiplication builds up. Thus,

If 8760 be divided by 365, it gives 24.

If divided by 24, it gives 365.

MULTIPLICATION of Decimal Fractions: See *Decimal*.

MULTIPLICATION of Fractions. See in *Fractions*.

MULTIPLICATION of Logarithms. See *Logarithms*, N. 6.

MULTIPLICATION by Logarithms. See *Logarithms*, N. 8.

MULTIPLICAND, in Arithmetick, is the Number to be multiplied. See more in *Multiplication*.

MULTIPLICATOR, in Arithmetick, is the Number by which you multiply, or the Number multiplying.

MULTIPLIER, the same with *Multiplicator*.

MULTIPLYING Glass is a Glass formed or ground into several Planes or Faces, making Angles one with another; through which the Rays of Light issuing from the same Point undergoes different Refractions, so as to enter the Eye from every Surface in a different Direction; as if they came from several Points.

A MULTO *fortiori*, or à *Minori ad majus*, is an Argument often used by *Littleton*, and is fram'd thus: If it be so in a Feoffment passing a New Right, much more is it for the Restitution of an Ancient Right, &c.

MULTISILIQUEOUS Plants [*in Botany*] those that after each Flower have a divers, distinct, slender, and often crooked *Siliqua* or Pods, in which their Seed is contained, which open themselves when they ripen and let the Seeds drop, the same that are called *corniculate* Plants.

MULTONES *Auri*, were formerly Pieces of Gold Coin imprest with the Figure of a Sheep or Lamb (perhaps the *Agnus Dei*) from whence they had this Name, *Multo*, being then used for a Sheep, as *Mutto* and *Muto* was also, whence our Word *Mutton*. This Coin was more common in France; but that it was sometimes used also in England, appears by a Patent of 33 Ed. 1.

MUNDICK, is a *Marchasite* found in the *Timmines*, of a Colour white, yellow, or green. They sometimes call it *maxy*; it seems to be a kind of *Sulphur*, because Fire only separates it from the *Tin*, and it evaporates into Smoke. The *mundick* Ore is easily known by its brown sad-coloured glittering, and by its soon colouring your Fingers. Some say this nourishes the *Tin*, and yet they say also, where much *Mundick* is found there is little or no *Tin*; and 'tis certain, that if there be any *Mundick* left in melting the *Tin*, it makes it thick and *cruddy*, as they speak; that is, it is not so ductile as otherwise it would be.

MUNICIPAL [*Municipilis* L.] an Epithet applied to those customary Laws, which obtain in any particular City or Province which have no Authority in the Neighbouring Places; and also to those Officers who are chosen to defend the Interests of Cities, their Rights and Privileges, &c. as a Lord Mayor, Alderman, &c.

MUNIMENTS, among the Lawyers, are taken for such Authentick Deeds and Writings; as a Man can defend the Title to his Land or Estate by.

MUNIONS, in Architecture, are the short upright Posts or Bars that divide the several Lights in a Window Frame.

MURAGE, in Law, signifies a Toll or Tribute to be levied for building or repairing of Publick Walls; and is due either by Grant or Prescription. It seems also to be a Liberty granted to a Town by the King, for the Collecting Money towards the Walling of the same.

MURDER, according to our Law, is a Wilful and Felonious Killing of another upon premeditated Malice,



Malice, whether secretly or openly, and whether *Englishman* or *Foreigner*, living under the King's Protection. And this prepened Malice is Twofold: 1. *Express*, When it may be evidently proved that there was Ill-will; 2. *Implied*, When one killeth another suddenly, having nothing to defend himself, as going over a Stile, or such like: For in such a Case, or when a Man killeth a meer Stranger, the Law presumeth that he had Malice against him, or else he would not do it without any Manner of Provocation.

MURDERERS, are small Pieces of Ordnance, either of Brass or Iron, having *Chambers* (that is, Charges made of Brass or Iron) put in at their Breeches. They are mostly used at Sea, at the Bulk-heads of the Fore-castle, Half-deck, or Steerage, in order to clear the Decks when an Enemy boards the Ship; they are fastned and traversed by a Pintle, which is put into a Stock.

MUSCLE; a Muscle is only a Bundle of *Fibres*, which being closely compacted at each End, make the two Tendons, each of which is inserted into some fixt Parts of the Body. Every one of these Fibres consists of a prodigious Number of lesser *Fibrillæ*, which are so many very slender *elastick Canals* bound about by small transverse parallel Threads, which divide these hollow *Fibrillæ* into so many *elastick Cystes* or *Vesiculæ*, which are orbicular, being formed of two concave Segments, of a Sphere. Into every one of these *Vesiculæ*, an Artery, Vein, or Nerve enter; the first to bring and carry back the Blood; the last to carry thither the *Liquidum Nervorum* or Nervous Juice, which mingling in the *Vesiculæ*, with the Blood, doth very probably (it having an acid Taste, and therefore consisting of Particles which are pointed and so qualified to prick and break the Globules of the Blood) let out the imprisoned *elastick Air* which before was contained in the Globules, into those little *Vesiculæ*, whereby the *elastick Cells* of the Fibres will be blown up, and thereby their Longitudinal Diameters, from Cell to Cell straitned; and this must contract the Length of the whole Fibre, and so move that Organ, to which one of the Tendons is fixt. This, saith Dr. Cheyne, *Phil. Prim. Natural Religion*, p. 221. is undoubtedly the true manner of *muscular Motion*.

He thinks also, that the broken Shells of these Globules are carried back by the Veins to the Lungs to be new formed; which is the Reason that muscular Motion is so constantly and uniformly performed, as long as the Blood Globules and Animal Spirits are in sufficient Plenty.

MUSCLE, the chief Instrument of Voluntary Motion in an Animal Body. The Parts of a *Muscle* are Three; its *Head*, *Belly*, and *Tail*. The *Head* of a *Muscle* is its Beginning, and as it were, the Centre of its Motion; and this is always fixed to the most stable Part. The *Belly* of a *Muscle* is its Middle Part, which is tumid, or extended, in all muscular Motion. The *Tail* is the other End or Extreme, which is fastened into the Part to be moved.

MUSCLE *Vein*. This Vein is Two-fold, the *Superior* and the *Inferior*. The former arises from the Muscles of the Neck, and the latter from the upper Muscles of the Breast; and this sometimes opens into the External Jugular.

MUSCULAR *Fibres* [in *Anatomy*] are the fine Threads or Fibres, of which the Body of the Muscles is composed.

*Muscular Motion*, or which way the Belly of a *Muscle* comes to be swelled, and consequently its

Extremes brought nearer together, in order to move the Part required, is a very great Mystery; as indeed many other Things are in an Human Body, which is *fearfully and wonderfully made*. There have been many *Hypotheses* to solve this, which whether satisfactory or not, must be left to every one's Judgment to determine.

Dr. Willis supposes the Animal Spirits, brought by the Nerves, to be lodged in the *Tendons* of the *Muscles*, and that meeting with other active Particles brought from the Blood, they make an *Effervescence*; by which the *carnous Fibres* of the *Muscle* are agitated, stuffed and swelled, and so the whole *Muscle* is contracted in its Length.

Steno imagines the *carnous Fibres* of the *Muscles*, as also the opposite *Tendons*, to be in their Construction like to *Parallelograms*; by an Alteration of the Angles of which, the *Muscle* is contracted, and the Head and Tail brought near together: And this he thinks may be done without the Accession of any New Matter.

Dr. Mayo falls nearly in with Dr. Willis his Notion: He thinks the Contraction of the *Muscle* is made by an *Effervescence*, arising from the Mixture of the *Sulphurous Saline* Particles of the Blood, with the *Nitro-aerious* ones brought by the Nerves which blow up and distend the Belly of the *Muscle*.

M. Du Verney fancies this Intumescence may be made without *Fermentation*, by the Animal Spirits, and a Juice from the Arteries, running into the Tendons and *carnous Fibres*, and so extending themselves, as Ropes and Cats-gut Strings swell in moist Weather.

Dr. Croon supposes every *carnous Fibre* to be made up of small Globules or Bladders, all opening one into another, into which the *nutritious Juice*, and one or two other fine and active Liquors, entering, do, by means of the natural Heat, make an Ebullition or Effervescence; by which means the whole Body of the *Muscle* becomes extended, and its Length contracted, &c.

Borelli takes the Fibres of a *Muscle* to consist of a Chain of divers *Rhombs* or *Lozenges*, whose *Area* are capable of being enlarged or contracted, according as the nervous Juice, together with the *Lympha* and Blood, are let and forced into or out of them, *ad Imperium Animæ*.

The accurate Mr. Cowper seems to think the Blood to be the true *Pondus*, by which the *Action* of a *Muscle* is composed: and that either by a Turgescence begun in the *Parieties* of the Cells of the *Fleshy Fibres*, caused by the Liquor contained in the Nerves, agitated *ad Imperium Animæ*; or by the Construction of the *Venous Ducts*, there becomes a Repletion of their Cells, whereby the Length of the *Fibrillæ* is contracted.

Dr. Chirac, Professor of Medicine at Montpellier, supposes, and thinks he can prove it analytically that every *Muscle* being composed of a vast Multitude of Fibres, like Threads, folded up all together within one Skin or Membrane, and every Fibre having its proper Vein, Artery, and Nerve, it hath also from Space to Space several little Cavities or Pores which are of an oblong Form, when the Muscle is slack or flaccid; but the Blood circulating through the Muscle, is continually disposing into those Pores a *Sulphurous Recrement*, abounding with *Alkali Salts*, which meeting with the Spirits that flow also by the Nerves into those oval Pores, their *Nitro-aerial* Particles ferment in a most violent manner with the *Saline* ones of this *Sulphureous Recrement*, and thereby distend the



Pores so, as to make them change their long oval Figure into a round one; and thus the Muscle must be contracted.

MUSCULAR Membrane [in *Anatomy*] a Membrane that is suppos'd to invest the whole Body immediately under the adipose Membrane, call'd *Membrana musculorum communis*, and also *Panniculus carnosus*.

MUSCULAR Veins, [in *Anatomy*] several Veins so called, two of which come from the Skin and the hind Muscles of the Thigh, and end in the *Subclavian*, and also three others call'd Musculars, which are distinguish'd into *upper*, *middle* and *under*; the first ends in the Trunk of the *Vena Cava*, the two others open into the external *Iliac Vein*.

MUSCULUS *Stapidis*, is a Muscle of the Ear, which lies hid in a Bony Pipe, excavated in the *Os Petrosum*, almost at the Bottom of the *Tympanum*, whence it takes its Origin. Its Belly is big and fleshy, and suddenly forming a very thin Tendon, which descends to its Insertion at the Head of the *Stapes*: When this acts, it draws the *Stapes* upwards, to the *Foramen Ovale*.

MUSCULUS *Nauticus*. See *Tibialis Posticus*.

MUSCULUS *Tubæ novus Valsalva* vel *Palato-Salpingæus*, a Muscle arising broad and tendinous from the Edge of all the lunated Part of the *Os Palati*, several of its Fibres being spread upon the Membrane that covers the *Foramen Narium*, then growing into a small thin Tendon, it is reflected about the Hook-like Process of the inner *Ala* of the *Processus Pteregoidæus internus*, and is inserted carnosus into all the membranous, fleshy, and cartilaginous Parts of the Tube. Its Use is to dilate and keep open this Channel. *Myogr. comparatæ Specim. p. 47.*

MUSCULUS *Auriculæ Anterior*, is a new (5th) Muscle of the *Auricle*, and added to the four before discovered by *Casseri*, by the Discoverer of it *Valsalva* in his Treatise of the Ear.

It arises from the investing Membrane of the Temporal Muscle, above that Part of the *Zygoma* which proceeds from the *Os Temporis*; thence running strait down, it parts into two; one of which is inserted to the Fore Part of the upper Cavity of the *Concha*; and the other a little higher, into the Fore Part of the Cavity of the *Scapula*. He describes there also two new Muscles more, which from their Situation he gives these Names to.

MUSCULUS *Tragi*, and } but in lean ema-

MUSCULUS *Anti-Tragi* } ciated Bodies he owns these are not to be seen.

MUSICK is one of the Seven Sciences, commonly called *Liberal*, and comprehended also among the *Mathematical*; as having for its Object *Discrete Quantity* or *Number*, but not considering it in the Abstract, like *Arithmetick*; but with relation to *Time* and *Sound*, in order to make a delightful Harmony.

This Science is also *Theoretical*, which examineth the Nature and Properties of *Concords* and *Discords*, explaining the Proportions between them by Numbers: And *Practical*, which teacheth not only Composition, that is to say, the manner of Composing all sorts of Tunes or Airs; but also the Art of singing with the Voice, or playing upon Musical Instruments.

MUSICK. What follows is a brief Account of the *Elements of Musick*, communicated by the ingenious Mr. *John Perks*.

The Thing considered in Musick is *Harmonical Sound*, or Sound so manageable, as to please the Ear and Fancy of the Hearers.

The Sense of Sound is caused in us by the trembling motion of the Air, excited by the Percussion of some solid Body, as a Bell, String, Pipe, &c.

This Trembling of the Air is quick or slow, according to the Impression given by the Voice or Instrument. The quicker the Trembling is, the more acute and sharp is the Sound; and the slower, the more grave and flat.

The same Degree of Quickness of the Trembling or Pulses of the Air being continued, the same Sound or Note is continued also. Hence a sounding String keeping the same Note to the last, shews, that its Vibrations are in equal Time from the greatest to the least Ranges of its motion.

The shorter a musical String is, *cæteris paribus*, the quicker are its Vibrations, and the more acute its Note: And, contrariwise, the longer a String is, the more slow are its Vibrations, and the more grave its Note.

Hence the Proportions of the Degrees of *Acuteness* and *Gravity* of Notes are computed from the Divisions of a *Monochord*, or strained musical String.

The Proportion of *Quickness* in the Vibrations of two Strings, and also of the Pulses of the Air excited thereby, is *Reciprocal* or *Counter* to the Lengths of the Strings; so twice the Length gives (*cæteris paribus*) half the Quickness of Pulses (or half the Number of Pulses in the same time.) If the Lengths are as 3 to 2, the Velocity of Pulses is as 2 to 3, &c. Hence the Relation or Proportion of musical Notes is determined as follows.

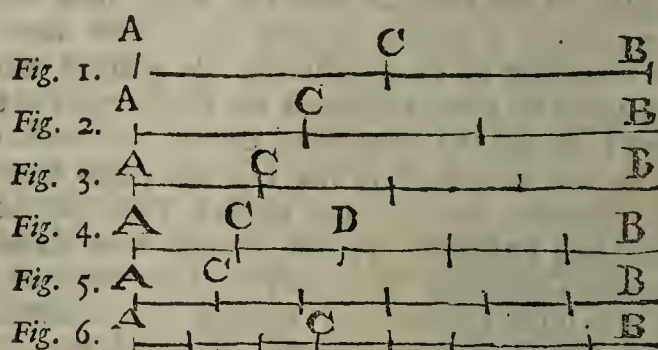


Fig. 1. Let AB represent a musical String (suppose a *Bass Viol*) strained so as to give a clear Sound. Let it be divided into two equal Parts at C. Stop the String at C, and the Part CB (being struck) will sound an *Octave* or *Eighth* to the Note of the whole String AB when unstopt. CB is in Length to AB as 1 to 2; and the *Vibrations* of CB to those of AB (in the same Time) as 2 to 1. Hence the Proportion of an *Octave* or *Diapason* is *Dupla*, Double, 2 to 1.

Fig. 2. Let the String AB be divided into three equal Parts, of which AC is one. If the String be stop'd in C, the Part CB will sound a *Fifth* to the Note of the whole String. CB is to AB (in length) as 2 to 3, and the *Vibrations* of CB are to those of AB as 3 to 2 in Quickness. Hence the Proportion between the two Notes of a *Fifth* (*Diapente*) is *Sesquialtera* 3 to 2.

Fig. 3. Let AC be a Quarter of the whole String AB. Stop in C, and the Part CB will sound a *Fourth* to the Note of the whole String AB. Hence the Proportion between the Notes of a *Fourth* (*Diatefferon*) is *Sesquitertia*, 4 to 3.

Fig. 4. Let AC be a Fifth Part of the String AB. Stop in C, so will CB sound a *Greater Third* to the Note of the whole String AB. The Proportion



Proportion therefore of the Notes of a *Greater* or *Sharp Third* is *Sesquiquarta*, 5 to 4.

Fig. 5. Let AC be the sixth Part of AB. Stop in C, so will CB sound a *Lesser* or *Flat Third* to AB, whose Proportion is therefore *Sesquiquinta*, 6 to 5;

If DB (Fig. 4.) be  $\frac{3}{2}$  of AB, BD will sound a *Greater Sixth* to AB.

If CB (Fig. 6.) be  $\frac{5}{8}$  of AB, CD will sound a *Lesser Sixth* to AB.

From what hath been said it follows, that

If	{	2 3 4 5 6 5 8 10	{	Pulses of the Acuter Note be equal in Time to	{	1 2 4 5 3 5	{	Of the lower Note, the Con- cord is	{	An Eighth or Oc- tave A Fifth. A Fourth. A greater Third. A lesser Third A greater Sixth. A lesser Sixth.

When two Notes in any of the precedent Proportions one to another, are sounded together; their Sounds are agreeable and pleasing to the Ear, and are therefore called *Concords*. Of these the Eighth and Fifth are called *Perfect Concords*; Thirds and Sixths are called *Imperfect Concords*: The Fourth (anciently accounted a *Concord*) is by modern Musicians accounted a *Discord* to the Bass in Consort-Musick, as wanting a Fifth under to compleat the Harmony.

The above-mentioned are all the Simple Concords that the Ear allows of. If the Proportion between any two Notes be compounded of the Proportion of an *Octave* with that of any other Concord, it retains the Name and Nature of the added Concord. So a *Tenth*, that is, an *Eighth* and *Third*, is accounted but a *Third*; and so of the rest.

All other Proportions between 2 Notes sounding together produce *Discords*, or Sounds harsh and unpleasing to the Ear, the Coincidencies of the Pulses being too remote one from the other.

By this it appears, that *Commensurability* in the Quickness of the Vibrations is necessary to *Concordance*; and the smaller the Numbers are that express the Proportion of the Pulses in the same Time, or the nearer their Coincidencies, the more perfect is the Harmony. And consequently if their Pulses be of *Incommensurable Velocities*, the *Discord* will be in the highest Degree harsh and displeasing.

From this Account of Concords and Discords may a Reason be given of several Phænomena of Sounds, as particularly why two Strings of a *Bass Viol* that are *Unisons* or *Octaves* one to the other, if one be struck, the other will tremble so as to be sensibly perceived if a small Bit of Paper be laid on it. For the String that is struck putting the Air into a certain Degree of trembling, which being the same, or next Degree of proportional Quickness to that of the unstruck String, sets it a

trembling also. This Experiment, (and others of like Nature) Dr. Holder very well illustrates by the Instance of a *Pendulum*, which if you blow into Motion, and continue to blow uniformly as it begins to go from you, it may be continued in Motion as long as you please; but if you blow irregularly (sometimes as it goes and sometimes as it comes) its Motion will be check'd, and at last cease.

Being once in a Room where was a *Bass Viol*, and striking one of the Strings, a loose Quarry of Glass in the Window jarr'd every Time that String was struck, which it would not do upon striking any of the other discording Strings. The Reason of which seems to be, that the Times of the Vibrations of the loose Quarry were equal (or in near Concordance) to those of the String.

From the foregoing Proportions may those of all other musical Intervals be computed by Compounding or Dividing. I'll give a few Instances, and for more refer to Dr. Holder's *Grounds and Principles of Harmony*, where all Things are more fully treated of.

Let it be required to find what Proportion the extreme Notes will have of *Fourth* and *Fifth* added together. The Proportion of the Notes of a Fifth is express'd by  $\frac{3}{2}$ , that of a Fourth by  $\frac{4}{3}$ : Compound these Proportions, so  $\frac{3}{2} \times \frac{4}{3} = \frac{12}{6} = \frac{2}{1}$ , which is the Proportion of an *Octave*: Whence it appears that a Fourth and Fifth added together make an Eighth. Again, to find the Difference between a Fifth and a Fourth; Divide  $\frac{3}{2}$  by  $\frac{4}{3}$  [ $\frac{3}{2} \div \frac{4}{3} = \frac{9}{8}$ ] it gives  $\frac{9}{8}$ , which is therefore the Proportion of a greater Tone by which a Fifth and Fourth differ.

To find the Difference between a Greater Sixth and a Fifth; Divide  $\frac{5}{3}$  (the Proportion of a Greater Sixth) by  $\frac{3}{2}$  (that of a Fifth) it gives  $\frac{10}{9}$  [ $\frac{5}{3} \div \frac{3}{2} = \frac{10}{9}$ ] which is the Proportion of a *Lesser Tone*.

To find the Difference of a Fourth and Greater Third, Divide  $\frac{4}{3}$  by  $\frac{5}{4}$  [ $\frac{4}{3} \div \frac{5}{4} = \frac{16}{15}$ ] it gives  $\frac{16}{15}$ , which is therefore the Proportion of a *Semi-tone* (or lesser gradual Interval) by which a greater Third and Fourth differ. In like manner may other Intervals be compared.

In a gradual Series of 8 Notes, there are contained 5 Tones, (or whole Notes) 3 Greater and 2 Lesser, and 2 *Semi-tones* (or half Notes) whose Order among themselves is different according to the Key.

The Key is the Principal or Fundamental Note of a Tune, to which the rest have proper Relations, and with which the Bass always concludes.

The Key is called *Flat* or *Sharp*, not as to the Key-Note it self, but with Respect to the *Third*, *Sixth*, and *Seventh* above it. A *Flat Key* is that which hath above it (and reckoning from the Key) a *Lesser Third*, *Sixth* and *Seventh*; and a *Sharp Key* is that which hath a *Greater Third*, *Sixth* and *Seventh*; the 2d, 4th, and 5th being the same Intervals in both Keys.

The annexed Figures shew how a String is to be divided to express the Notes in a Flat or Sharp Key.



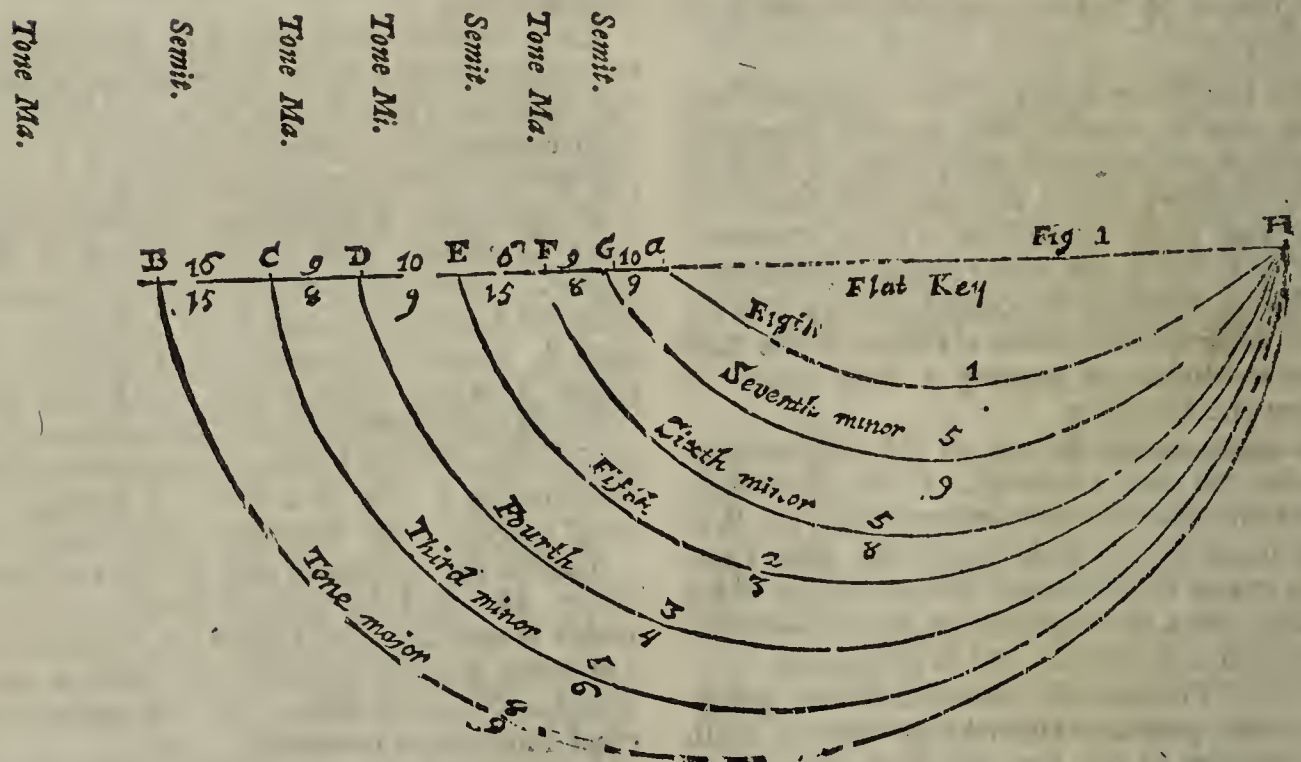
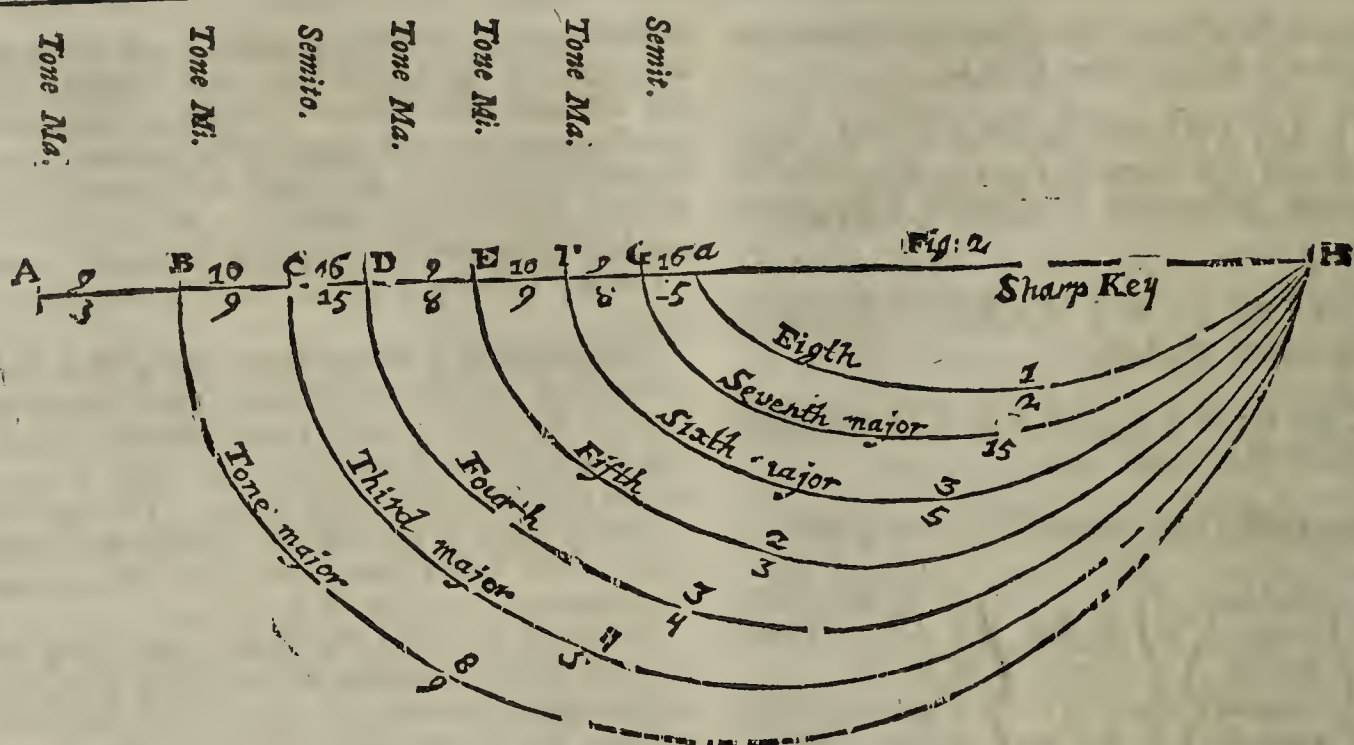


Fig. 1. AH is the whole String, whose Sound gives the Key-Note; B, C, D, &c. shew the Divisions (of Stops) to express the Notes of a Flat Key.

The Numbers set to each little Part of the Line, shew the Proportions of the next immediate Notes one to another, and also of the Length of Strings from these Divisions to H: So  $\frac{15}{9}$  standing between D and E, shews, that DH is to EH as 10 to 9; and so of the rest.

Upon the Arched Lines is express'd the Relation of the several Notes to the Key, and also of the founding Part to the whole String. So EH is  $\frac{2}{3}$  of a whole String, and Sounds a Fifth to the Key. In like manner Fig. 2. shews the Divisions in a Sharp Key.

Suppose AH (Fig. 1.) be a Line 24 Inches long, then will AB be  $2\frac{2}{3}$  Inches; AC 4 Inches, AD 6 Inches, AE 8 Inches, AF 9, AG  $10\frac{2}{3}$  Inches, A a 12 Inches.

To express the Notes of a Sharp Key, let AH (Fig. 2.) be a Line 24 Inches long, then is AB  $2\frac{2}{3}$  Inches, AC  $4\frac{4}{3}$  Inches, AD 6 Inches, AE 8 Inches, AF  $9\frac{1}{3}$ , AG  $11\frac{1}{3}$ , A a 12 Inches.

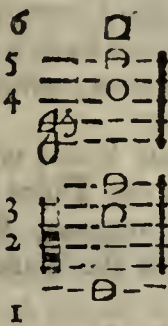
If a middle-siz'd Gut-string be strained over a Line thus divided at about a fifth Part of an Inch Distance from the Line, the Divisions mark'd in the Line will shew where to stop the String so as to express the several Notes.

Above and below the Eighth the Notes ascend and descend in the same order repeated, and therefore all Eighths are called by the same Names, and (in the Gamut) sign'd with the same Letters of the Alphabet.

I cannot here omit two Observations that have been made relating to what has been said: The first by Sir Isaac Newton in his Treatise of Light and Colours, where considering the Colours produced by the Sun's Light passing through a Triangular Glass Prism, and measuring the Space that each of the seven Colours (Red, Orange, Yellow, Green, Blue, Indico, Violet) take up, he found the Divisions of the whole Length of the coloured Image, to be the same with that of a Monochord into the Tones and Semitones of an Octave. See pag. 92. of his Opticks.



The other Observation is concerning the Proportions of the Notes in a full Close upon an Organ or Harpsicord, viz. That they are as the Numbers 1, 2, 3, 4, 5, 6, in order, beginning from the Bass, as is here prick'd down.



All the Notes commonly used in Mulick are compriz'd in their Order in a Scale which is call'd

The G A M U T.

Ela	f	e	
Dla sol	d	e	
C sol fa	c		
B fa b mi	b		
Alamire	a		
G sol re ut	g		
F fa ut	f		
E la mi	e		
D sol re	d		
C sol fa ut	c		
B fa b mi	b		
A la mi re	a		
G sol re ut	g		
F fa ut	f		
E la mi	e		
D sol re	d		
C fa ut	c		
B mi	b		
A re	a		
G gamut	g		

Sometimes Ledger Lines are added above and below, as Occasion requires.

In the first Column are set the Names by which the Keys or Notes, are commonly called, as Gamut, Are, &c. In the second Column are set the 7 Letters belonging to the several Lines and Spaces. The third Column contains the Cliffs, and shews how many Degrees, or Notes, they are one above or below the other; which being known, the other Degrees of Distance are easily computed.

Five of these Lines, with their Spaces are commonly sufficient for the pricking of a Tune; therefore is the whole Scale divided into 3 Systems or Staves, compassed in by arched Lines. Of these the lower 5 belong to the Bass, and are distinguish'd by this Mark  $\text{C}$  upon the Line of F. The uppermost 5 Lines contains the Treble Part, which hath for its Cliff  $\text{G}$  or  $\text{G}$  upon the Line of G. The Tenor, or middle Part, hath for its Cliff this Mark  $\text{H}$  upon the Line of C, which only is its proper Line, the other 4 being borrowed from the Treble and Bass.

Of Sol-fa-ing, and Tuning Notes when prick'd down.

In learning to sing, it is necessary that the Notes Names, Places, and Difference in Sound from each other be well known, and a Habit got (by Practice) of naming and turning them right at Sight.

The Names in Use are but these 4 Monosyllables, sol, la, mi, fa; which yet must (and has been) own'd incongruous; for seven distinct

Notes should certainly have as many Notes to distinguish them by. I shall therefore, after I have given a short Account of the Use of those Names, propose another way of naming the Notes in Singing, which I judge (and have found by Experience) to be better.

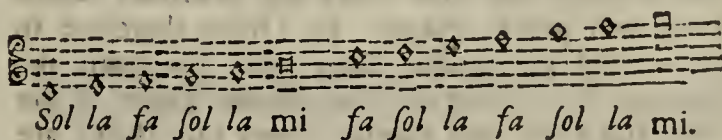
In order to Sol-fa a Tune, (that is, to name and tune the Notes right) the Place of mi must be first known, which is B in the Scale, as being the next Note above three Tones immediately succeeding each other. In case of Flats (b) and Sharp (#) the Place of mi is found as in this Table.

When  $\left\{ \begin{array}{l} B \text{ is} \\ B \text{ and E are} \\ B E \text{ and A are} \end{array} \right\}$  Flat, mi stands in  $\left\{ \begin{array}{l} E \\ A \\ D \end{array} \right\}$

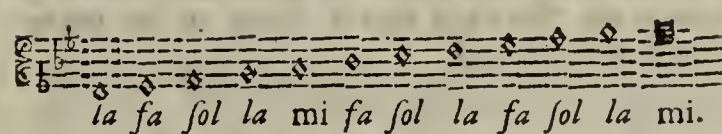
When  $\left\{ \begin{array}{l} F \text{ is} \\ F \text{ and C are} \\ F G \text{ \& C are} \end{array} \right\}$  Sharp, mi stands in  $\left\{ \begin{array}{l} F \\ C \\ G \end{array} \right\}$

The Place of mi being known, you ascend above mi by fa, sol, la, fa, sol, la; and descend below mi by la, sol, fa, la, sol, fa, calling all Eights by the same Name.

Mi in B.



Mi in A.

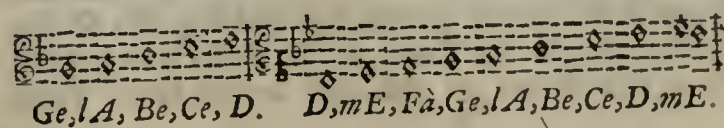
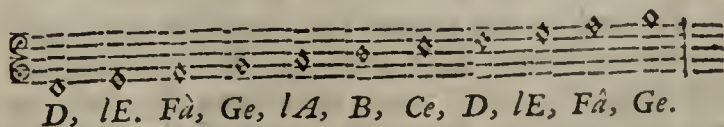


I'll now propose the other way of naming the Notes, that I mention'd before.

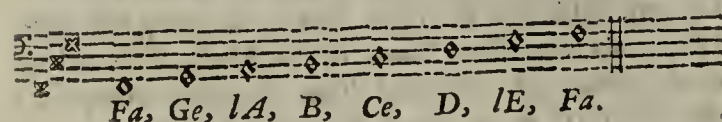
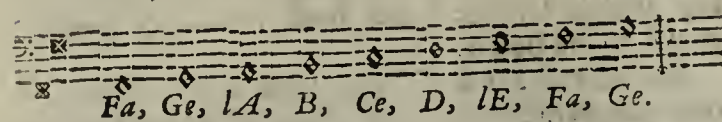
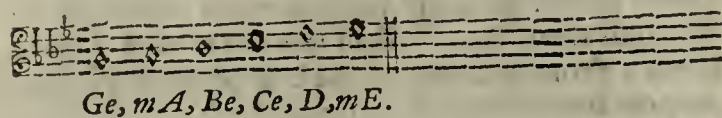
The seven musical Notes being express'd in the Gamut by the seven first Letters of the Alphabet, A, B, C, D, E, F, G; let these Letters be their Names whereby to express them in Singing. Only, for better Sound's sake, and to accommodate them to the Variations by Flats and Sharps, let A and E be call'd lA and lE. Let F be call'd Fa (with a broader Sound as in the Word Fall.) G and C are to be pronounc'd Ge and Ce; so will the 7 Names be lA, B, Ce, D, lE, Fa, Ge. When A and E are mark'd to be flat at the Beginning of the Staff of Lines, let them be called mA and mE; when B is Flat call it Be, as in the Word Benefit. When F is mark'd to be a Sharp, let it be call'd Fa, as in the Word Fatal. When C is Sharp call it Cee (its proper Name.) In like manner, when G is Sharp, let it be called Gee, not Ge.

By this means the proper Letter expressing each Note is preserv'd, and also a Provision made for Variation of the Name, according as the Note is varied to Flat or Sharp.

Examples of the Notes Names.



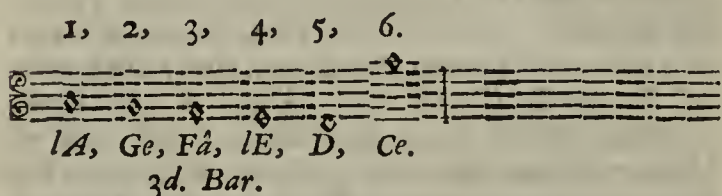
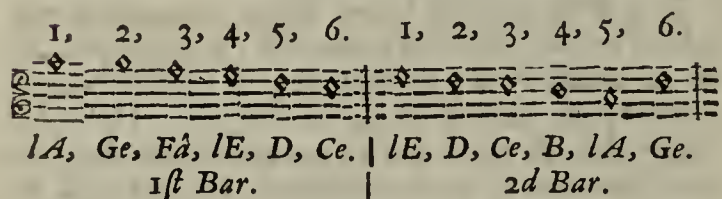




To sing a Tune true according as it is prick'd, is best and soonest learnt by the Assistance of one skill'd in Musick; but where such cannot be had, a Person who has naturally a Musical Ear and Fancy, may, (by the Method I shall here direct) attain to a competent Skill in *Plain-Song*, at least. In order to which, I shall only suppose that he can sing the Tune of *Six Bells*, which (with us in *England*, where that Number of Bells is so common) is no great Thing to suppose in a capable Learner.

There being in every *Octave* six *Tones* and two *Semitones*, (as has been shewn) it is necessary to true Singing, that these *Tones* and *Semitones* should keep their proper Places. In Order therefore to know and distinguish *Tones* and *Semitones*, the Learner must observe, that in the Tune of Six Bells, the *Third* and *Fourth* Notes (or Bells) are distant a *Semitone*; all the rest are distant (each from its next) by a *Tone*. A good Ear will easily observe the *Third* and *Fourth* Notes to be nearer Sound than the rest.

To apply the Tune of Six Bells to Notes prick'd in the Treble Cliff.

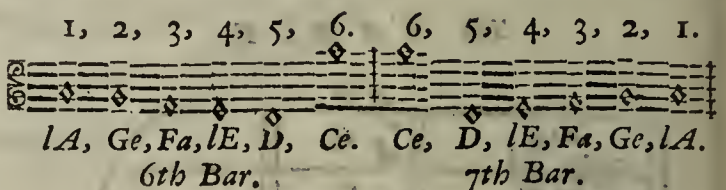
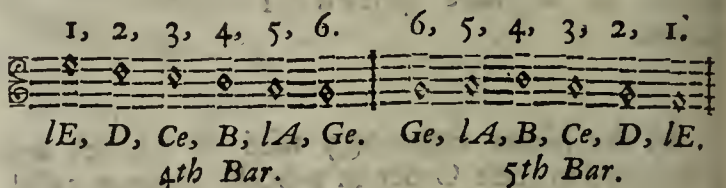


In this Example (consisting of 3 Bars or Divisions) you have in the first Bar the Notes of Six Bells, beginning at the Leger-line above the Staff, which is the Place of *A*, (according to the Order in the *Gamut*.) Begin with your Voice pretty high (that you may after reach the lower Notes in the other Bars) and sing 3 or 4 times distinctly the first six Notes, calling them 1, 2, 3, 4, 5, 6. Then call them by their proper Names, (set under the Staff) *l A, Ge, Fa, l E, D, Ce*; singing them in the same Tune that you did the Numbers 1, 2, 3, 4, 5, 6.

Proceed to the second Bar, but first sing your former six Notes once or twice over, holding out the Note *l E* a little longer than the rest; then repeating only the three last Notes of the first Six, begin at *l E* in the second Bar, and sing *l E, D, Ce, B, l A, Ge*, in the Tune of Six Bells, keeping the three first Notes of this Six in the same Tune

with the three last of the former Six. So are you led gradually one Note above an *Octave*. If you stop at the lower *l A*, (one Note short of the last 6, (you will have a compleat *Octave* from *l A* above to *l A* below, which is the Order of Notes in a Flat Key.

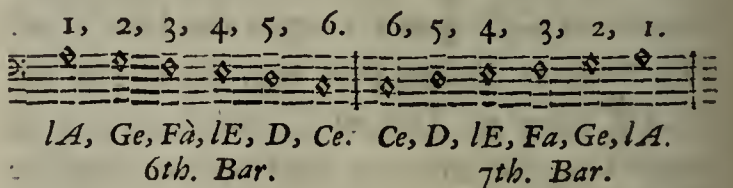
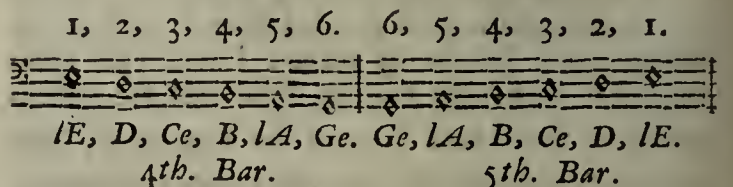
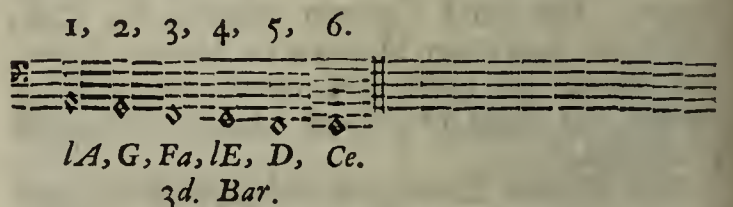
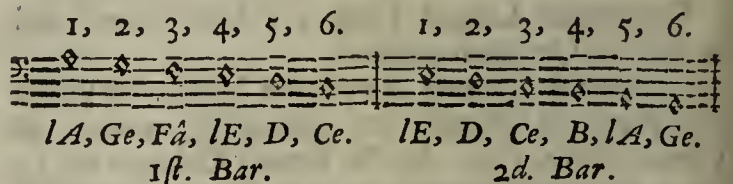
If your Voice will reach another six Notes, you may, in the Third Bar, repeat the two last Notes of the foregoing Six, and sing *l A, Ge, Fa, l E, D, Ce*, in the Tune of Six Bells.



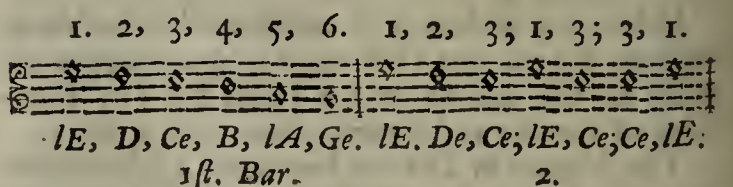
In the 4th Bar, having sung the 6 Notes *l E, D, C, B, l A, Ge*, in the Tune of 6 Bells several times, try to sing them backward, as in the 5th Bar, *Ge, l A, B, Ce, D, l E*; which with a little heed may easily be done, as may also the other Six, beginning at *l A* in the 6th Bar.

Here note, 1. That the Tune of Six Bells may begin either at *l A* or *l E*, and no where else without altering the Property by Flats or Sharps, of which anon. 2. That the two *Semitones* lie, one between *B* and *Ce*, and the other between *l E* and *Fa*.

The same Directions will serve for the following Notes set in the *Bass Cliff*, and therefore I shall only set down the Notes.



Examples of rising and falling the Voice by Leaps in the Treble Cliff.





1, 2, 3, 4; 1, 4; 4, 1. 1, 2, 3, 4, 5;  
  
*lE, D, Ce, B; lE, B; B, lE. lE, D, Ce, B, lA;*  
 3. 4.

1, 5; 5, 1. 1, 2, 3, 4, 5, 6; 1, 6; 6, 1.  
  
*lE, lA; lA, lE. lE, D, Ce, B, lA, Ge; lE, Ge; Ge, lE.*  
 5.

1, 2, 3, 4, 5, 6. 6, 5, 4, 3, 2, 1.  
  
*lE, D, Ce, B, lA, Ge. Ge, lA, B, Ce, D, lE.*  
 6.

6, 5, 4.  
  
*Ge, lA, B; Ge, B; B, Ge. Ge, lA, B, Ce;*  
 7. 8.

*Ge, Ce; Ce, Ge. Ge, lA, B, Ce, D; Ge, D; D, Ge.*  
 9.

*Ge, lA, B, Ce, D, lE; Ge, lE; lE, Ge.*  
 10.

In the first Bar, sing the 6 Notes in order. In the 2d Bar, sing only the 3 first two or three times, then skipping the second Note *D*, sing *lE*, *Ce* several times, and then upwards *Ce*, *lE*. In like manner proceed to the following Bars, singing the Notes in each Bar as they are prick'd, till you have learnt to raise and fall the Voice by the Leaps there set down.

1, 2, 3, 4, 5, 6.  
  
*lE D, C, B, lA, Ge. Ce, Be, lA, Ge,*  
 11. 12.

*lA, Ge, Fa, lE, D, Ce; Ce, Ce; Ce, Ce.*

In the 12th Bar, sing the 6 Notes, and in singing hold *Ce* the 3d Note, somewhat longer than the rest, the better to hit it in beginning afterward at that Note: Then in the 12th Bar begin at *Ce*, and repeat *Ce, B, lA, Ge*, several times, and then going 2 Steps back, sing Six from *lA* to *Ce*, below, which will be an *Octave* to the Note *Ce* above.

Examples of raising and falling the Notes by Leaps in the *Bass Cliff*.

1, 2, 3, 4, 5, 6. 1, 2, 3; 1, 3; 3, 1.  
  
*lE, D, Ce, B, lA, Ge. lE, D, Ce; lE, Ce; Ce, lE.*  
 1. Bar. 2.

1, 2, 3, 4; 1, 4; 4, 1. 1, 2, 3, 4, 5;  
  
*lE, D, Ce, B; lE, B; B, lE. lE, D, Ce, B, lA;*  
 3. 4.

1, 5; 5, 1. 1, 2, 3, 4, 5, 6; 1, 6; 6, 1.  
  
*lE, lA; lA, lE. lE, D, Ce, B, lA, Ge; lE, Ge; G, lE.*  
 5.

1, 2, 3, 4, 5, 6. 6, 5, 4, 3, 2, 1.  
  
*lE, D, Ce, B, lA, Ge. Ge, lA, B, Ce, D, lE.*  
 6.

*Ge, lA, B; Ge, B; B, Ge. Ge, lA, B, Ce;*  
 7. 8.

*Ge, Ce; Ce, Ge. Ge, lA, B, Ce, D; Ge, D; D, Ge.*  
 9.

*Ge, lA, B, Ce, D, lE; Ge, lE; lE, Ge.*  
 10.

1, 2, 3, 4, 5, 6.  
  
*lA, Ge, Fa, Le, D, Ce. Ge, Fa lE, D, Ce.*  
 11. 12.

*lE, D, Ce, B, lA, Ge; Ge, Ge; Ge, Ge.*

When Flats or sharps (*b*, *♯*) are set at the Beginning of the Staff by the Cliff, they alter the Places for beginning the 6 Notes, by removing the *Semitones* (one or both) from their original Places; the Flat [*b*] removing its Notes a *Semitone* lower; and the Sharp [*♯*] removing them a *Semitone* higher. When there are no Flats and Sharps, the Tune of Six Bells begins at *lE* and *lA* only; in other Cafes as follows.

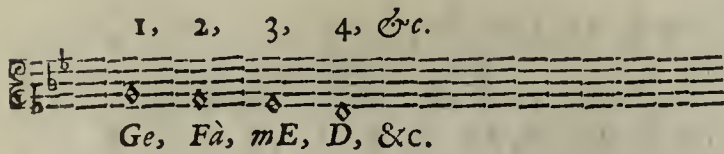
When  $\begin{cases} B^{\flat} \text{ is flat} \\ B^{\flat} \text{ and } m E \text{ are flat} \\ m A, B \text{ \& } m E \text{ are flat} \end{cases}$  begin the Tune of 6 Bells at  $\begin{cases} lA \text{ \& } D, \\ Ge \text{ \& } D. \\ Ge \text{ \& } Ce, \end{cases}$

When  $\begin{cases} Fa \text{ is sharp} \\ Fa \text{ and } C \text{ are sharp} \\ Fa G \text{ \& } C \text{ are sharp} \end{cases}$  begin the Tune of 6 Bells at  $\begin{cases} B \text{ \& } lE. \\ B \text{ \& } Fa. \\ C \text{ \& } Fa. \end{cases}$

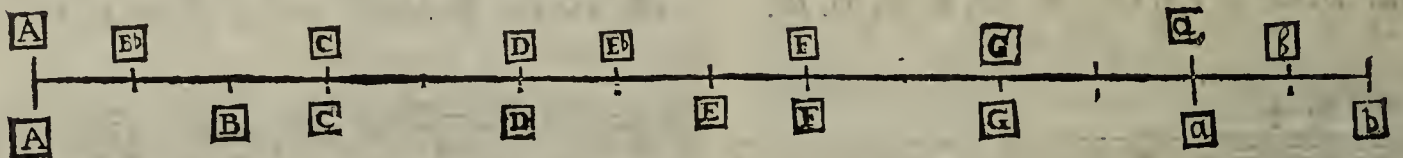
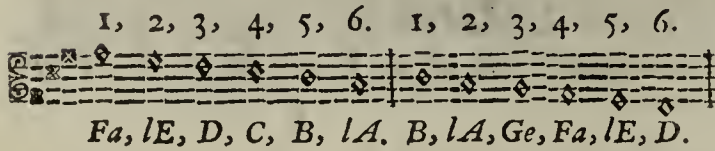
An Example when *B* and *E* are flat.

1, 2, 3, 4, 5, 6. 1, 2, 3, 4, 5, 6.  
  
*Ge, Fa, mE, D, Ce, Be. D, Ce, Be, lA, Ge, Fa.*  
 Ge,





An Example when F and C are sharp.



It may be a good Way to give Learners a Notion of the Alterations made by Flats and Sharps; in the Distances of the Notes, to divide a Line into 12 equal Parts (which will do for this Purpose, tho' in Strictness they should not be all equal) as the Line A a is here divided. Provide 8 little square Papers with these 8 Letters, A, B, C, D, E, F, G, a, upon each, one; and place them as on the underside of the Figure, which shews their natural Order, and the Places of the *Semitones* between B and C, and between E and F. Suppose I should now see the Order of the *Tones* and *Semitones* when B and E are signed flat in the Staff thus, to do this, I remove the Papers mark'd with B and E, one Degree (answering to a *Semitone*) lower, or nearer to A; and then the Papers will stand in Order as above the Line, and the two *Semitones* are now between A, B, and D, E. In case of *Sharps*, the Letter design'd to be sharp must be removed one Degree (or twelfth Part) higher, or nearer to a.

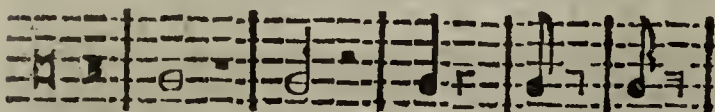
Thus may all the Varieties be represented to the Eye, and the Reason of beginning the Six Notes as is directed, be also understood.

#### Of the Quantity of Notes as to Time.

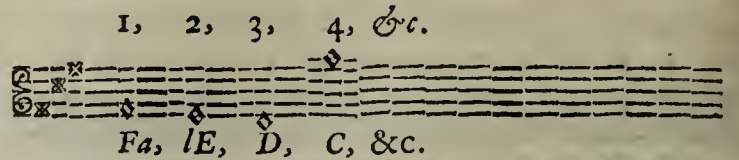
Besides the giving to Notes their right Tune (according to their Places in the Staff of 5 Lines) Regard is also to be had to the *Length* or *Shortness* of Time they are express'd in, which is known by the Figure or Shape of the Character by which they are prick'd on the Lines.

The Names and Figures of the usual Notes in Respect of Time, and their correspondent Rests are as follow:

Breve, Semibreve, Minim, Crochet, Quaver, Semiquaver.



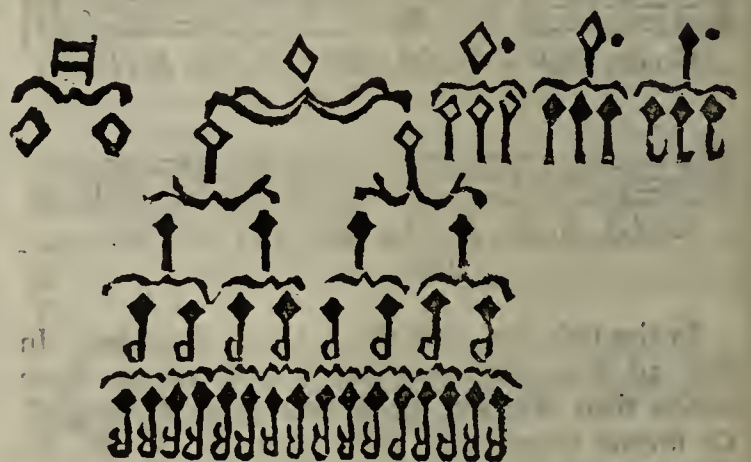
The Strokes or Marks set after each Note are called *Rests* or *Pauses*, and denote a Ceasing or Intermision of the Sound for the Time of the Notes they are join'd to.



By the Table above, and these two Examples, may be understood how to place the Six Notes in any other Case of Flats and Sharps, or in other Cliffs. The *Semitones* in all Cases, lie between the 3d and 4th Notes of the Six.

See more, with Application to *Psalmody*, in a Treatise called, *A New and Easy Method to learn to Sing by Book*.

The Proportion of the foregoing Notes, one to the other, is express'd in this Scheme.



One *Breve* is equal in Time to two *Semibreves*; one *Semibreve* to two *Minims*; one *Minim* to two *Crotchets*, &c.

When a Prick (.) is set after any Note, it increases its Quantity half as much more. So is equal in Time to a *Semibreve* and *Minim*.

A prick'd *Minim* is equal in Time to a *Minim* and *Crochet*.

If the Words *one, two, three, four* be pronounc'd in a reading Tenor, the Time of pronouncing each Syllable may be accounted the Measure or Time of one *Crochet*; and consequently, *one, two*, gives the Time of a *Minim*; *one, two, three*, of a prick'd *Minim*; *one, two, three, four*, of a *Semibreve*.

This may suffice for an Entrance, referring the Reader to Books for farther Information.

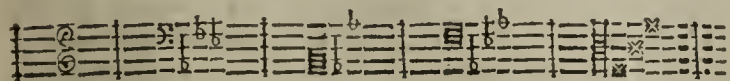
#### Of Singing in different Cliffs.

The Difference of Cliffs is what doth perplex Learners. They who can sing in the *Treble Cliff*, are at a Loss when they come to the *Tenor* or *Bass* Cliffs: I will therefore here give a Table, wherein all the usual Cliffs (or Positions of them) are so compar'd and order'd, that he who can sing readily in one Cliff, may sing in any other in the Table.

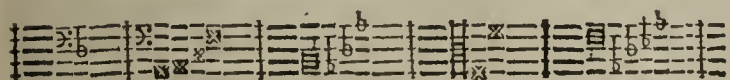


*A Table whereby all the usual Cliffs may be reduced to any one Cliff desired.*

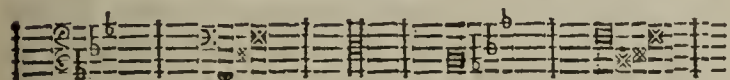
## I.



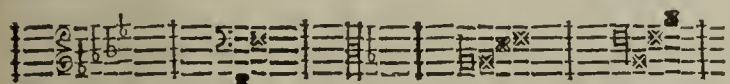
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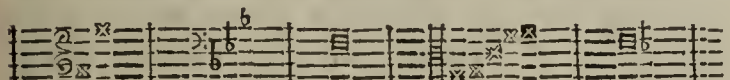
## III.



## IV.



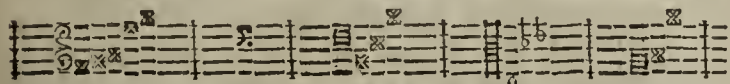
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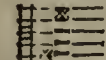

## VI.




## VII.



This Table, consisting of 7 Staves or Classes, contains in each Class all those (usual) Cliffs wherein the *Semitones* lie in the same Places of the Staff; and consequently what is prick'd in any Cliff, may be sung (or play'd) as if it were prick'd in any other Cliff of the same Class.

E. G. Suppose a Person hath learnt to sing in the *Treble Cliff* only, and would sing Notes prick'd in the *Tenor Cliff* on the middle Line with F #, thus  let him look for this Cliff in the Table, and he will find it in the second Class, where, at the Beginning is  that is, the *Treble Cliff* with B flat. If he therefore sing the Notes as if they were in the *Treble Cliff* with B flat, he'll sing them as true as if he had understood the *Tenor Cliff*.

Ge, lA, B, Ce, D, lE, Fa, Ge.

Examp.   
Fa, Ge, lA, Be, Ce, D, lE, Fa.

In this Example, the Cliff at the Beginning of the Staff, is that to which the Notes are prick'd, and the Names (as in the *Tenor Cliff*) are set above them. At the End is set the *Treble Cliff*, in which the Notes may be sung, and their Names (as accounted in the *Treble Cliff*) as set under.

Dr. Wallis, in *Phil. Transact.* N. 243. takes into Consideration the strange Reports we have of the Power of the ancient Musick; and tho' he judges they are in a great Degree Hyperbolical, if not Fabulous; yet he thinks too that some Account

may be given of the great Effects it's said to have had, from these Considerations.

1. That Musick was then, if not *new*, a rare Thing; which the Rusticks, on whom it is reported to have had mighty Effects, had scarce ever heard before; and on *such*, a little Musick will do great Feats; as we find at this Day a Fiddle or a Bagpipe hath at a Country Morice-Dance.

2. Their Musick was much more Simple and Plain than ours now: They had no Consorts of 2, 3, 4, or more Voices or Parts; but one single Voice or Instrument apart; which to a *rude* Ear is much more taking than compound Musick: That not exceeding their Capacity, whereas *This* confounds them quite, and is by no means distinguishable by them, so as to affect them with the Harmony of its Parts.

3. Musick, with the Ancients, was of a much larger Extent than what we now call by that Name; for *Poetry* and *Dancing* (*i. e.* comely Motion) were then accounted Parts of Musick, when it had arriv'd to some Degree of Perfection. And we see that *Verse* of it self alone, if in good Measure, and moving Words, and this set to a Musical Tune, sung by a decent agreeable Voice, accompanied with soft Instrumental Musick only, if with any; *i. e.* such as doth not drown or obscure the emphatical Expressions (like what we call *Recitative Musick*, tho' I doubt not more justly managed; for I hope the same Tone did not serve with them for making Love, Fighting, and delivering Letters) will work strangely upon the Ear, and move all the Affections suitable to the Tune and Ditty, especially if attended with a *Gesture* and *Action* suitable; for we see that *suitable Action* alone doth on the *Stage*, give great Life and Force to Words; and therefore all this together might easily operate very strongly on the Fancies and Affections of ordinary People, not used to such kind of Treatments: For if the deliberate reading of a Romance, (when well penn'd) will produce Mirth, Tears, Joy, Grief, Pity, Wrath or Indignation, suitable to the respective Intents of it, much more would it do, if accompanied with all these Attendants.

4. If it be ask'd, why may not all this be done now? I answer, no doubt it may: If the Address be made in proper Words, emphatically spoken, and in just Measures, with moving Arguments, pronounced by an agreeable Voice, and attended with a decent Gesture, and not drown'd by too much Musick, or over-acted by apparent Affectation.

5. We should understand also, that the usual Design of what we *now* call *Musick* is very different from that of the Ancients; for that which we call so, was but with them the *Harmonick*, *i. e.* but one Part of their whole Musick, which consisted of Words, Verse, Voice, Tune, Instrument, and Acting.

6. When Musick arriv'd to good Perfection, it was applied by the Ancients to the exciting this or that particular Affection, Passion, or Temper of Mind; the Tunes and Measures being suitably adapted to such Designs; whereas those are now almost quite neglected in our present Musick; the chief Design being now to please the Ear, when by a sweet Mixture of different Parts and Voices, with just Cadences and Concords intermix'd, a grateful Sound is produced: But this only the Judicious Musician, or one a good while used to such Compositions and Performances, can distinguish.



7. 'Tis true, that even this Compound Musick admits of different Characters; some is more brisk and airy, others more solemn and grave, as the different Subjects do require. But that which is most proper to excite particular Passions and Dispositions, is such as is more Simple and Uncompounded, such as a Nurse's languid Tone lulling her Babe to Sleep, or a continued Tale (as in Ireland) or reading in an even Tone; or the soft Murmur of a little Rivulet running upon Gravel or Pebbles inducing a quiet Repose to the Spirits: and on the other Hand, the Briskness of a Jig, &c. on a Violin exciting to Dance; for these are more operative for such Ends than elaborate Compositions of full Musick.

The same excellent Author in N. 249. hath a judicious Discourse about the Imperfection of that noble Instrument an *Organ*; where he observes, That each Pipe is designed to express a distinct Sound at such a Pitch, or at such a determinate Degree of Gravity or Acuteness, i. e. as it is now called of Flatness or Sharpness; and the Relative or Comparative Consideration of the two or more such Sounds or Degrees of Flatness or Sharpness is the Ground of what we call *Concord* and *Discord*; that is, a soft or harsh Coincidence. Concerning which there was among the ancient Greeks two Sects of Musicians; the *Aristoxenian* and *Pythagorean*: But both agreed thus far, that *Diatefferon* and *Diapente* do together make up *Diapason*; i. e. a *Fourth* and a *Fifth* make up an *Eighth*. And the Difference of these two, of a 4th and a 5th, they agreed to call a *Tone*; which we now call a *whole Note*. Such is that in our present Musick of *la mi*; for *la, fa, sol, la*, or *mi, fa, sol, la*, is a perfect 4th; and *la, fa, sol, la, mi*, or *la, mi, fa, sol, la*, is a perfect *Fifth*. The Difference of which is *la, mi*; and this the Greeks called the *Diazeutick Tone*, which disjoins two *Fourths* on each Side of it; and being added to either of them, makes a *Fifth*; which was That, in their Musick from *Mese* to *Paramese*, or in *Ours* from *A* to *B*, supposing *mi* to stand in *B fa B mi*, which is accounted its natural Position.

Now in order to this, *Aristoxenus* and his Followers took that of a 4th, as a known *Interval*, by the Judgment of the Ear, and that of a *Fifth* likewise, and consequently that of an *Octave*, as the Aggregate of both, and that of a *Tone* as the Difference of those two. And this of a *Tone* (as a known *Interval*) they took as a common Measure by which they estimated other *Intervals*: And accordingly they accounted a *Fourth* to contain two Notes and  $\frac{1}{2}$ , a *Fifth* three Tones and  $\frac{1}{2}$ , and consequently an *Eighth* six Tones, or five Tones and two half Tones; and at this Rate our practical Musicians talk of *Notes* and *half Notes* at this Day; supposing an *Octave* to consist of twelve half Notes.

But *Pythagoras* and those that follow'd him, not taking the Ear alone to be a competent Judge in a Case so nice, chose to distinguish these, not by equal *Intervals* but by due *Proportions*. And this is followed by *Zarlino*, *Kepler*, *Cartes*, and other Writers on *Speculative Musick*, in this and the last Age. Accordingly they accounted an *Octave* to be, when the Degree of Gravity or Acuteness of one Sound to another is double, or as 2 to 1. That of a 5th when 'tis *Sesquialteral*, or as 3 to 2. That of a 4th, when 'tis *Sesquitercian*, or as 4 to 3; accounting that the sweetest Proportion which is express'd in the smallest Numbers; and therefore next to an *Unison* they accounted the *Octave*, or of 2 to 1. Then that of a 5th, or of 3 to 2, and then that

of a 4th, or of 4 to 3. And thus that of a 4th and 5th do together make an 8th, for  $\frac{4}{3} \times \frac{3}{2} = \frac{4}{2} = 2$ . Or the Proportion of 4 to 3, compounded with that of 3 to 2 is the same with that of 4 to 2, or 2 to 1, and consequently the Difference of these two, which is that of a *Tone* or full Note, is that of 9 to 8; for  $\frac{4}{3} \times \frac{3}{2} = \frac{4}{2}$ . Or if out of the Proportion of 3 to 2 you take that of 4 to 3, the Result is that of 9 to 8. Now according to this Computation 'tis plain, that an *Octave* is something less than 6 full Notes; for as hath been demonstrated by *Euclid*, and some others since, the Proportion of 9 to 8 being 6 times compounded, is something more than that of 2 to 1, for  $\frac{9}{8} \times \frac{9}{8} \times \frac{9}{8} \times \frac{9}{8} \times \frac{9}{8} \times \frac{9}{8} = \frac{531441}{262144}$  which is more than  $\frac{524288}{262144} = 2$ . And this being the Case they allowed to the *Diazeutick Tone*, *la, mi*, the full Proportion of 9 to 8, as the unalterable Difference between the *Fifth* and the *Fourth*. All the Difficulty was how the remaining *Fourth*, viz. *mi, fa, sol, la*, should be divided into three Parts, so as to answer pretty near the *Aristoxenians* two Tones and an half; and might all together make up the Proportion of 4 to 3, which is that of a *Diatefferon* or *Fourth*.

Many Attempts were made to this Purpose, and according to these, they gave Names to the different Kinds of Musick, viz. the *Diatonick*, *Chromatick*, and *Enharmonic*, with the several *Species* or lesser Distinctions under these *Generals*.

The first was that of *Euclid*, (which obtained generally for many Ages) and which allows to *fa, sol*, and to *sol, la*, the full Proportion of 9 to 8; and therefore to *fa, sol, la*, which we now call the *greater Third*, that of 81 to 64; for  $\frac{9}{8} \times \frac{9}{8} = \frac{81}{64}$ , and consequently to that of *mi, fa* (which is the remainder to a *Fourth*) that of 256 to 243; for  $\frac{81}{64} \times \frac{4}{3} = \frac{27}{243}$ , i. e. if out of the Proportion of 4 to 3, we take that of 81 to 64, the Result is that of 256 to 243. To this they gave the Name of *λείμμα*, that is, the Remainder (over and above two Tones.) But in common Discourse, when we don't aim at speaking exactly, nor desire to be so understood, 'tis usual to call it an *Hemitone* or *half Note*, as being very near it; and the other two whole Notes: And this is what *Ptolemy* calls *Diatonum Ditonum*, (or the *Diatonick* Kind with two full Tones.) Against this it is objected, That the Numbers of 81 to 64, are too great for that of a *Ditone* or *greater Third*; which is not harsh to the Ear, but is rather sweeter than that of a single *Tone*, whose Proportion is that of 9 to 8. And in that of 256 to 243 the Numbers are yet greater much; whereas there are many Proportions (as  $\frac{5}{4}$ ,  $\frac{6}{5}$ ,  $\frac{7}{6}$ ,  $\frac{8}{7}$ ) in smaller Numbers than that of 9 to 8, of which in this Division there is no Notice taken, and consequently this Division is not the most convenient.

To rectify this, there is another Division thought more convenient; which is *Ptolemy's* *Diatonum Intensum*, of the *Diatonick* Kind, but more *Intense* or *Acute* than the other; and this instead of two full Tones for *fa, sol, la*, assigns what we now call a *Greater* and a *lesser Tone*; and this seems to have been more followed by the nicer Musicians of this and the last Age. To *fa, sol*, they assign the Proportion of 9 to 8, which is their *greater Tone*, and to *sol, la*, that of 10 to 9, which they call the *lesser Tone*; and therefore to *fa, la*, the *Ditone* or *greater Third*, that of 5 to 4; for  $\frac{9}{8} \times \frac{10}{9} = \frac{10}{8} = \frac{5}{4}$ , and consequently to *mi, fa*, which is remaining of the *Fourth*, that of 16 to 15. For  $\frac{5}{4} \times \frac{4}{3} = \frac{5}{3}$ ; that is, if out of that of 4 to 3 you take that of 5 to 4, there remains that of 16 to 15.

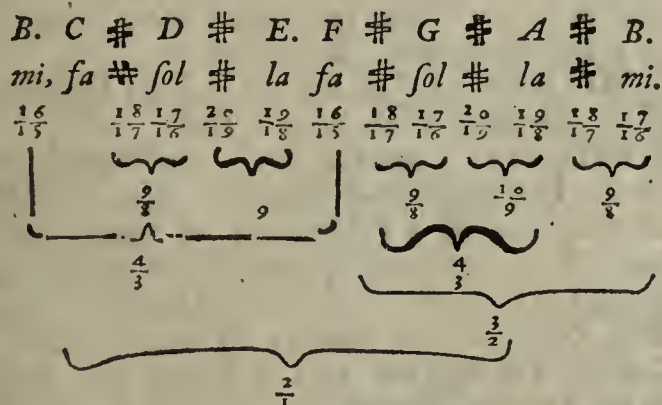


Omitting to speak of the other Ways of Division, this  $\frac{1}{2}$  is what we now call an *Hemitone* or *half Note* in *mi, fa*:  $\frac{2}{3}$  is that of the *greater Tone* in *fa, sol*; and  $\frac{1}{3}$  that of the *lesser Tone* in *sol, la*.

Only with this Addition, That each of these *Tones* is now, on Occasion, by *Flats* and *Sharps* divided into *Hemitones* or *half Notes*; which answers to what the *Greeks* called the *Change of Mood*; and which is now done by removing *mi* to another *Key*, viz.  $\frac{2}{3} = \frac{1}{18} = \frac{1}{17} \times \frac{1}{18}$ : and  $\frac{1}{3} = \frac{2}{18} = \frac{2}{17} \times \frac{1}{18}$ .

This by the Help of *Flats* and *Sharps*, as they are now called, (dividing each whole Note by its *greater* or *lesser* into two *half Notes*, or such as we call so.) The whole *Octave* is divided into 12 Parts or *Intervals*, contained in an Organ between 13 Pipes; and these are commonly called *Hemitones* or *half Notes*: Not that each is precisely an half Note, but somewhat near it, and so called. I say by *Flats* and *Sharps*, because sometimes one and sometimes the other is used: As for Instance, a Flat in *D* or a Sharp in *C*, do either of them denote a middling Sound (tho' not precisely in the middle) between *D* and *C*, flatter than *D*, and sharper than *C*.

According to this, supposing *mi* to stand in *B fa B mi* (which is accounted its natural Place) the Sound of each Pipe is to bear these Proportions one to another, viz.



And so in each *Octave* successively following: And if the Pipes in each *Octave* be fitted to Sounds in these Proportions of Gravity and Acuteness, it will be supposed according to this Hypothesis, to be perfectly proportioned.

But instead of these successive Proportions for each *Hemitone*, it hath been found necessary (if I do not mistake the Practice) so to order the 13 Pipes containing the 12 Intervals or *Hemitones*, as that their Sounds, as to Gravity and Acuteness, shall be in continual Proportion (that is, each to its next following in one and the same Proportion) which altogether shall compleat that of the *Octave* or *Diapason*, or as 2 to 1, whereby it comes to pass, that each Pipe doth not express its proper Sound, but very near it, tho' something varying from it: And this they call *Bearing*, which is somewhat of Imperfection in this noble Instrument the Organ, the Top of all.

It may be ask'd, Why may not the Pipes be so ordered as to have their Sounds in just Proportion as well as their Bearing?

I answer, it may very well be so, if all Musick were composed to the same Key, or as the *Greeks* call it, the same *Mode*; as for Instance, if in all Compositions, *mi* were always in *B fa B mi*, then the Pipes might be ordered in such Proportions as I have now designed. But Musical Compositions are made in great Variety of *Modes*, or with great Diversity of the Pitch. *Mi*, is not always placed in *B fa B mi*, but sometimes in *E la mi*, sometimes in *A la mi re*, &c. And indeed there is no

one of these *B Pipes* but may be made the Seat of *mi*; and if they were exactly to any one of these Cases, they would be quite out of Order for all the rest. As for Instance, if *mi* be removed from *B fa B mi* (by a Flat in *b*) to *E la mi*, instead of the Proportions but now designed, they must be thus ordered.

B	C	D	E	F	G	A	B
fa	sol	la	mi	fa	sol	la	fa
$\frac{1}{17}$	$\frac{1}{18}$	$\frac{2}{17}$	$\frac{1}{18}$	$\frac{1}{17}$	$\frac{1}{18}$	$\frac{2}{17}$	$\frac{1}{18}$

Where it is manifest, that the Removal of *mi* doth quite alter the whole Series of the Proportions. And the same would again happen if *mi* be removed from *E* to *A*, by another Flat in *E*: and again if removed from *A* to *D*, and so perpetually. But the *Hemitones* being made all equal, they do indifferently answer all the Positions of *mi* (tho' not exactly to any) yet nearer to some than to others; whence it is that the same Tune stands better in one Key than in another.

Nor can this ever be remedied, but only in Part, by making the Imperfection something less by the Interposition of *quarter* or *half quarter Notes*, &c. for it hath been long since demonstrated, that there is no such thing as a just *Hemitone* practicable in Musick (and the like holds for the Division of a *Tone* into any other Number of equal Parts) for supposing the Proportion of a Full Note or *Tone* to be  $\frac{2}{3}$  or as 9 to 8; that of the half Note must be, as  $\sqrt{9}$  to the  $\sqrt{8}$ , that is, as 3 to the  $\sqrt{8}$ , or 3 to  $2\sqrt{2}$ , which are incommensurable Quantities: and that of a Quarter Note will be as  $\sqrt[4]{9}$  to  $\sqrt[4]{8}$ , which is yet more incommensurable. And the like for any other Number of equal Parts; which therefore will never fall in with the Proportions of Number to Number.

So that this can never be perfectly adjusted for all Keys, without something of *Bearing*, by multiplying the Pipes. Unless for every Key, or for every different Place of *mi* there be a different Set of Pipes, of which this or that is to be used, according as (in the Composition) *mi* is supposed to be in this or that Place. Which vast Number of Pipes for every *Octave*, would greatly increase the Charge, and after all, make the whole impracticable.

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*Cleonidis Musica. Fol.*

*Fabii Stapulensis Elementa Musices.*

*Salmon's Theory of Musick in Philos. Transf. N.*

302.

**MUSKET-Baskets**, in Fortification, are Baskets of about a Foot and half high, and 8 or 10 Inches Diameter at the Bottom, and a full Foot at the top: They are filled with Earth, and are set on low Parapets or Breast-works, or on such as are beaten down, that the Musqueteers may fire between them at the Enemy, and yet be tolerably well secured against their Fire.

**MUTE.** (A Term in Law) A Prisoner is said to stand *Mute*, when he refuses to plead to an Indictment.

**MUTULE**, in Architecture, is a kind of Square *Modillion*, set under the Cornice of the *Dorick* Order, and so called from the Word *Mutilus*, Maim'd, or Imperfect, because they represent the ends of the Rafter which are crooked or bent; in like manner, as the Beams, or Joints are represented by the *Triglyphs* in the *Frize* of the same Order.

**MUTUUM**, in the Civil Law, is a *Loan* simply so called; or a *Contract* introduced by the Law of Nations, in which a Thing that consists in Weight, (as suppose Bullion) in Number, as Money; or in Measure, as Corn, Wine, Oil, &c. is given to another upon Condition that he shall return another Thing of the same Quantity, Nature, and Value, upon Demand.

So that this is a Contract without Reward, and admits, properly speaking, of no Recompence. And therefore where Use and Interest is agreed on, they arise from some distinct particular Argument, or by Custom of the Country.

**MYDRIASIS**, [*μυδρίασις* Gr.] is a too great Dilatation of the *Pupil* of the Eye, which makes the Sight dim, because too much Light is then admitted into the Eye.

**MYELOS**, [*μυελος* Gr.] the Marrow of the Bones, or of the Brain, or Spinal Marrow.

**MYLOGLOSSUM**, [*μύλη* a Mill and *γλώσσα* Gr. the Tongue.] is a pair of Muscles which arise about the backside of the Grinding Teeth, and are inserted into the Ligament of the Tongue, and are said to turn the Tongue upwards. *Blanchard.*

These from their Use, I suppose are the same which our Mr. *Cowper* calls *Styloglossus*, a Muscle, which arising sharp and fleshy from the *Processus Styloides*, descends obliquely forward, and is inserted to the Root of the Tongue immediately below the Implantation of the *Ceratoglossus*: This puts the Tongue inward, and turns it upwards.

**MYLOHOIDEUS**, [of *μύλη* and *ὁμοειδής* Gr.] is a Muscle which *Fallopins* makes double, but Mr. *Cowper* thinks it a single one, not being to be divided without great Violence: It possesses all that Space which is between the Lower Jaw, and the *Os Hyoides*; arising fleshy from both sides of the *Mandible* Internally, near the *Dentes Molares*; whence marching with a double Order of fleshy Fibres, the outwardmost of which pass directly

to their Implantation in the *Os Hyoides*; and the middle run transversely over the following Muscles, being inseparably joined to each other with a middle Line, as is well express'd by *Bidloo*, (*Tab. 14.*) Besides the Uses commonly ascribed to this Muscle in moving the *Os Hyoides*, Tongue and *Larynx*, upwards and forwards, and to either side; its last described transverse Order of Fibres, have still a further use in Compressing the *Glandulæ Sublinguales*, which lie immediately under them on each side; whereby they hasten the Egress of the Spittle, from the Inferior Salival Ducts in the Mouth. Hence it is we employ these Muscles (as in the Action of *Deglutition*) when we want *Saliva* to moisten the Mouth: And in that Action also they supply it with fresh *Saliva*, to join with those Aliments where Mastication is not required; which Artifice of Nature deserves our Admiration. *Cowper.*

**MYLPHA**, according to some, the falling off of the Hairs of the Eye-lids; and with others Medicines against the falling off of the Hair. *Blanchard.*

**MYOCEPHALON**, [*μυοκέφαλον* of *μύα* a Fly and *κέφαλος* Gr. the Head,] is the falling off of a small Portion of the *Tunica Ovea*, just begun, like the Head of a Fly; whence it has its Name. *Blanchard.*

**MYODES** *Platysma*, is a broad Musculous Expansion in the Neck, proceeding there from a sort of a fat Membrane. *Blanchard.*

**MYOLOGIA** [*μυολογία* Gr.] is a Description of the Muscles of an Animal Body.

**MYOPIA**, [*μυωπία* Gr.] *Purblindness*, is a certain Dimness or Confusion of Sight in distant Objects, and yet a Perspicacity in things near at hand: It is occasioned by the Globe of the Eye's being too Convex, so as to unite the Rays before they come to the *Retina*: Wherefore since the *Distinct Base* falls not on the *Retina*, but perhaps in the *Vitreous Humour*, the Vision in such an Eye cannot be distinct, unless of Objects very near. But all such Persons may be helped by *Concave* Glasses, or Spectacles.

**MYOTOMIA** [of *μῦς* a Muscle and *τομή* Gr. a Section] an anatomical Dissection of the Muscles.

**MYRACH**, an *Arabian* Word, signifying the same with *Epigastrium*.

**MYRINX**, the same with *Tympanum*, or the Drum of the Ear.

**MYRMECIA**, [*μυρμηκία* Gr.] is a sort of Wart; they are harder and lower than those fleshy Tumours called *Thymi*, take deeper Root, and occasion greater Pain; broad below, and small at top, and emit less Blood. They are scarce ever bigger than a sort of Pulse called *Lupines*: They breed in the Palms of the Hand, or the Sole of the Foot. *Blanchard.*

**MYRTIFORMES** *Carunculæ* [in *Anatomy*] little fleshy knots adjoining to or rather in the Place of *Hymen* in Women. They are so call'd because they are about the Bigness of Myrtle-corns; some are of Opinion that they are deriv'd from the broken Membrane of the *Hymen*, being the Fragments of it shrunk up; others suppose them to be largest in Maids, and to grow less by degrees thro' the Use of Venery.



## N A A

## N A T

**N**AAM in Common Law, signifies a Distress, or the taking another Man's Goods, and is either *Lawful*, or *Unlawful*; *Lawful Naam*, is a reasonable Distress, proportionable to the Value of the thing Distrained for.

NABONASSER; in Chronology, the Æra of *Nabonasser* is famous. We know but little of the History of the Man; only that he was King of *Babylon*, and was also called *Belesus*; though some will have him the *Baladan* mention'd in *Isaiah* xxxix. 1. and 2 *Kings* xx. 12. some even conjecture that he was a *Mede*, and that he was set on the Throne by the *Babylonians*, upon their rising and shaking off the Subjection of the *Medes*.

The Beginning of this Prince's Reign is of great Importance in Chronology; by reason *Ptolemy* assures us, there were Astronomical Observations made by the *Chaldeans* from *Nabonasser* to his time; and *Ptolemy*, and the other Astronomers, account their Years from that Epocha. From the Observations quoted by *Ptolemy*, it follows, that the first Year of this Æra is the 747th Year before Jesus Christ, and the 3967th of the *Julian* Period. The Years of this Epocha are *Egyptian* Years, of 365 Days each, commencing on the 26th of *February*, and reckon'd according to the Computation of Astronomers, from Noon.

NADIR, is that Point of the Heavens seemingly under the Earth, which is diametrically opposite to the Point directly over our Head, *viz.* the *Zenith*; so that they are both as it were the Poles of the Horizon, and distant from it on each side 90 Degrees, and consequently fall upon the *Meridian*, one above, the other under the Earth; and whatever Distance one of them has from the Equator, and one of the Poles of the World; the same on the contrary, has the other from the opposite Pole, and adverse part of the Equator.

NÆVI [in the Animal Oeconomy,] certain Marks form'd on the *Fœtus* by the Imagination of the Mother, in longing for any thing, L.

NAIANT, or *Natant*; (*i. e.* Swimming) is the proper Term in Heraldry, to blazon *Fishes* in an Escutcheon, when they are drawn in an Horizontal Posture, *Fess-wise*, or Transversely across the Escutcheon; but if they are Erect, 'tis called *Hauriant*.

NAILING of Cannon, is the driving of a Nail, or Iron Spike, by force into the Touch-hole of a Piece of Artillery, so as to render it useless to the Enemy.

NAISSANT, *i. e.* *Nascent*, just new Born; the Herald's Term for a Lyon, or other Beast, appearing to be issuing or coming out of the middle of any *Fesse*, or other Ordinary; for if it come out from the lower Line of the Ordinary, they call it *Issuant*.

NAKED [in *Architecture*] as the naked of a Wall, &c. is the Surface or Plain from whence the Projectures arise, or which serves as a Ground to the Projectures.

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NAKED Fire, a Term used by the Chymists, for an open Fire, or one not pent or closed up.

NAKED Seeds [in *Botany*] are such Seeds of Plants as are not inclosed in any Pod or Case.

NAM } [in *Law*] signifies the taking or  
NAAM } distraining another Man's moveable Goods.

Lawful NAAM [in *Law*] is a reasonable Distress in proportion to the Value of the thing restrain'd for, and antiently was called *vif* or *mort*, as it was made either of quick or dead Cattle.

NAMATION, is the same as Distreining or taking a Distress; and in *Scotland* 'tis used for Impounding.

NAMIUM *Vetitum* [in old *Law Books*] an unjust taking the Cattle of another, and driving them to an unlawful Place, pretending Damages to have been done by them. L.

NAPHTA, a kind of liquid Sulphur or Bitumen, very soft and inflammable that exudes out of the Earth in several Places in *Chaldea*, particularly in the Place where the antient *Babylon* stood.

NAPIER's Bones. See *Neper's*.

NARCOSIS, is a privation of Sense, as in a Palsy, &c. or in taking of *Opium*, &c. whence strong Opiate Medicines are frequently called,

NARCOTICKS [*Ναρκοτικοί* of *ναρκωσις*, Gr. drowsiness] Opiates or Medicines that cause drowsiness or sleep.

NASALIA, the same that *Errhina*.

NASALIS or *Rhinæus*, is a Pair of proper Muscles belonging to the Cartilaginous Part of the Nose; it arises fleshy from the Extremity of the *Os Nasi* and adjacent Part of the *Os Maxillare*, and is inserted into all the Cartilages of the *Alæ*; its Use is to open and dilate the Nostrils, by putting that outwards.

NASCALIA, are little Globular Bodies which on some Occasions, are put into the Neck of the Matrix; they are made of the same Substance as the *Pessaria*. See *Pessaria*.

NASI *Os*, is a thin but solid Bone, which makes the upper part of the Nose; its upper end is join'd to the *Os Frontis* by the *Sutura Transversalis*: One of its Sides joins its fellow, and its lower is joined to the *Os Maxillare*, upon its lower end the Cartilages of the Nostrils are fastened; externally it is smooth, but internally it is rough.

NATES [in *Anatomy*] those two fleshy parts of the Body, commonly call'd the Hips and Buttocks.

NATES *Cerebri*, are two round Prominences in the Brain, behind the Beds of the Optick Nerves, which grow to the upper part of the marrowy Substance; they are small in Men, and larger in Brutes.

NATIVO *habendo*, was a Writ that lay to the Sheriff, for a Lord, whose Villain claimed for his Inheritance, run from him, for the apprehending and restoring him to his Lord again.



**NATTA**, is a great soft Tumour, with Pain and Colour, which grows most usually in the Back, but sometimes in the Shoulders; its Root is slender, yet it increases so prodigiously, that it will grow as big as a Melon, or a Gourd; it is made of fat Matter, and therefore ought to be reckoned amongst the *Steatomata*. See *Steatomata*. *Blanchard*.

**NATRON** } a kind of black, greyish Salt,  
**ANATRON** } taken out of a Lake of stagnant Water in the Territory of *Terrana* in *Egypt*.

**NATURAL Faculty** [in *Physicks*] is that Power, which arises from the Circulation of the Blood, that is perspicuous in all the Secretions that are performed within the Body, except only that Secretion which is made as the Origin of the Nerves.

**NATURAL Functions** [in *Physicks*] are those Actions whereby things taken into the Body are changed and assimilated so as to become parts of the Body, as the Actions of the Viscera, those Vessels that receive, retain, move, change, mix, secrete, and spend the Humours of the Body.

**NATURAL Inclinations** [in *Physicks*] are those motions or tendencies of the Mind, towards those things that seem to be good, which in either a greater or lesser degree are common to all Mankind.

**NATURAL** [in *Heraldry*] a Term us'd where Animals, Fruits, Flowers, &c. are blazon'd with the Colours they naturally have; though different from the Colours common in Heraldry, which is done to prevent the Armories being accused of Falsity, when blazon'd with Names unknown in Heraldry.

**NATURAL History**, is a Description of any of the natural Products of the Earth, Water or Air, such as Beasts, Birds, Fishes, Metals, Minerals, Fossils, together with such *Phænomena* as at any time appear in the Material World; such as Meteors, &c.

Some Writers on this Subject are these:

*Plinii Historia Naturalis Dalechampii*. Gen. 1631.

*Joan. Eusebii Nierembergii Historia Naturæ*. Antw. 1635.

*Mart. Lister Historia Conchyliorum*, Lond. 1685.

*Fr. Willoughbei Historia Piscium*.

*Ornithologia (eiusdem Authoris) sive de Avibus*.

*Moufettus de Insectis*. Lond. 1634.

*Garneri Historia Animalium*.

*Guernerus Rolfsius de Vegetabilibus*. Jenæ. 1670. 4to.

*Martyn Lister's Historia Animalium Angliæ*.

*Fred. Lackmund. Admirand. Fossilium Descriptiones*. Swammerdam's *Hist. Generalis Insectorum*.

*G. Pisonis de Re Naturali, &c. Indiæ Utriusque*.

*J. Johnston's Historia Naturalis*.

*History of Animals by the Academy of Sciences*.

*Plot's Natural History of* { *Oxfordshire*.  
   { *Staffordshire*.

*Historia Naturalis de Terrante*.

*Merret's Pinax Rerum Naturalium Angliæ*.

**NATURAL Day**. See *Day*.

**NATURALS** [in *Medicine*] that degree of Life and Strength, and the Causes and Effects of each that is in every Animal.

**NATURAL Horizon**, the same with *Sensible Horizon*. See *Horizon*.

**NATURAL Quantity**. See *Quantity*.

**NATURAL Philosophy**, is the same with what is usually call'd *Physicks*, viz. That Science which

contemplates the Powers of Nature, the Properties of Natural Bodies, and their mutual Action one upon another.

**NATURALIZATION**, is when an *Alien* born Subject, is made the King's *Natural*; and this must be done by Act of Parliament. *Vide Denizens*.

**NATURE**: This Word has usually these Significations.

First, and more strictly, it is taken for a peculiar Disposition of *Parts* in some particular *Body*; as we say, it is the *Nature* of *Fishes* to live in the *Water*.

Secondly, It is taken more largely for the Universal Disposition of all *Bodies*: And in this Sense 'tis nothing else, but the *Divine Providence*; forasmuch as it governs and directs all things by certain *Rules* and *Laws*, accommodated to the *Natures* of things.

Thirdly, It is taken for the *Essence* of any thing, not *Corporeal*, with the *Attributes* belonging to it: Thus we say, That it is the *Nature* of *God* to be *Good*, and the *Nature* of the *Soul* to *Think*.

**NATURE**. Besides these three Senses of this Word, it is sometimes used for this vast Machine of the *Universe*, the wise Production of *Almighty God*, consisting of a great Number of *lesser Machines*, every one of which is adjusted by the same Wisdom in Number, Weight and Measure.

*Laws* of **NATURE**, are Axioms and general Laws or Rules of Motion, and Rest, which natural Bodies observe, in all their Actions on one another; and in all the Changes which befall them in their natural State.

Of these Sir *Isaac Newton* has establish'd three.

1. Every body perseveres in the same State either of Rest or uniform rectilinear Motion: except so far as it is forced to change that State by some foreign Force.

Thus Projectiles persevere in their Motions, except so far as they are retarded by the Resistance of the Air and the Cause of Gravity. And thus a Top, the Parts of which are continually drawing one another out of their rectilinear Motion by their cohesion, ceases to run, round only because they are resisted by the Air, and the Friction of the Plain on which it moves.

Thus the larger Bodies of the Planets and Comets preserve their progressive and circular Motions undiminished for a long time in Regions that are void of all sensible Resistance.

2. The change of Motion is ever proportional to the moving Force, by which it is effected, and in the Direction of that Right Line wherein that Force is impress'd.

If a certain Force produce a certain Motion; a double Force will produce double the Motion; a triple Force triple the Motion, whether it be impress'd all at once or successively by degrees. And this Motion, (since it is ever directed to the same Point with the generating Force) if the Body were in Motion before, is either to be added to it as if the Motions conspire, or subtracted as where contrary; or added obliquely as where oblique, and is compounded with it according to the Determinations of each.

3. Reaction is always contrary and equal to Action, or the Actions of two Bodies upon one another are always mutually equal, and directed contrary ways.

Whatever



Whatever presses or pulls another, is equally press'd or pull'd by it. Thus if a Stone be press'd with ones Finger, the Finger is equally press'd by the Stone. If a Horse draw a Weight by a Rope, the Horse is equally drawn back by the Weight: for the Rope being equally stretch'd each way, will drive the Horse towards the Stone, with an equal endeavour to relax itself, and also the Stone towards the Horse, and will hinder the Progress of the one as much as it hinders that of the other. Again, if any Body by striking another do in any manner change its Motion, it will itself by means of the other undergo an equal change in its own Motion by reason of the Equality of the Pressure.

In these Actions the Changes are equal; we mean not those of the Velocities, but those of the Motions, the Bodies being supposed free from any other impediments; for the Changes of Velocities which are likewise made contrary ways, are reciprocally proportional to the Bodies, in as much as the Motions are equally changed.

This Law also obtains in Attractions.

Sir *Isaac Newton* at the End of his excellent *Opticks*, (Lat. Edit.) observes, That *Universal Nature* is very *Simple* and *Uniform* in its Operations. All the Motions of the heavenly Bodies are caused by that *Attracting Force*, Impulse or Power which we call *Gravitation*; and which is mutual amongst all those Bodies. All the *lesser Motions* of the Particles or Corpuscles of Matter whereby Bodies act on one another, are effected also, by some *attracting* and *repelling Force*; which is mutual and reciprocal amongst them.

The *Vis inertiae*, is a Principle *purely Passive*, by which Bodies persist in their State of Rest or Motion, whereby they receive Motion from others equal or proportionable to the *moving Force*; and whereby they *resist* as much as they are *resisted*. But from this Principle alone there never could have been any such Thing as *Motion*, any where in the Universe. There is a Necessity of supposing some other Principle to be the Origin of Motion, and its Constitution too: For from the various Compositions of two Motions, 'tis plain that there cannot be always the same Quantity of Motion in the World, for if two Globes, connected together by a slender Thread, be supposed to revolve with an uniform Motion round their common Centre of Gravity; and at the same Time that Centre should move on Uniformly also in a Right Line coincident with the Plane of the Globes Orbits: Then will the *Sum* of the Motions of those two Globes, whenever they happen to be both in the Right Line described by the common Centre of Gravity, be *greater* than the *Sum* of their Motions can be, when they are in a Line at Right Angles to that. By which Instance 'tis apparent, *that Motion is producible and destructible*. But from the *Tenacity* and *Attrition* of the Particles of Fluid Bodies, and the Imbecility of the Elastic Force in solid Bodies, we may conclude, that the course of *Nature* tends more to the *Destruction* than the *Production* of Motion; and indeed it is continually decreasing; for Bodies that are either so perfectly *hard*, or throughly *soft*, as to have no *Elasticity*, cannot be reverberated back from one another, and from their Impenetrability only it would follow that their Motion would stop, and terminate. If therefore there were any such things as the *Imaginary Vortexes* of *Des Cartes*, their Motion must be continually decreasing, and at last must quite cease. Since therefore Motion is thus continually decreasing in the Universe, we must have Recourse to some *active Principles*, to increase

and preserve it; *viz.* to such as the *Cause of Gravity* and *Fermentation*: By the former of which the Planets and Comets perpetually move in their Orbits, and Bodies by descending gain a great Velocity or large Quantity of Motion; and by the latter, the Heart and Blood of Animals is preserved in Motion and Warmth: The internal Parts of the Earth are perpetually getting Heat, many Bodies burn and shine, *Volcanoes* and *Earthquakes* are produced, and the Sun it self preserves his Light and Heat, and warms and cherishes all Things: For we find very little Motion in the World (except what is voluntary in free Agents) but what depends on these active Causes.

So that after well considering and understanding these Things, our admirable Author, (whose Piety and Goodness is as eminent as his profound Mathematick Learning and Penetration into Universal Nature) concludes, that our perfectly good, most wise, and Almighty Creator, did in the Beginning of the World, create Matter so as that its original Particles, from whence all corporeal Natures were to arise, were *solid, firm, impenetrable*, perfectly passive and moveable; and that they were made of such *Magnitudes* and *Figures*, and endued with such Properties, and in that Number and Quantity as was proportionable to the Space in which they were afterwards to move, in order to the most effectual obtaining of those Ends and Purposes for which they were created.

And these original primary Particles being perfectly solid, must be much more hard and firm than any Bodies that can be made out of them with Pores, hidden *Meatuses*, or Vacuities interspersed; that is, so perfectly hard and firm, that they can never be worn away or diminished; for 'tis not reasonable to suppose that there should be any Force or Power in the *ordinary Course* of Nature, that can divide *that* into more Parts, which God in the first *Creation* of Things, hath made *one*. As long therefore as these original Particles remain entire, there may for ever be Bodies made or composed of them; which shall have the same *Nature* and *Texture*: But if these can be broken, worn away, or diminished, then the Nature of corporeal Things which is dependent on these might be changed. Earth and Water composed of either such Particles as have been worn or broken, or of their Fragments, could not have at this Day, the same Nature and Texture, that original Earth and Water which was composed of these Particles when they were sound and entire. Wherefore that the Nature of Things should last, and their Natural Course continue the same; all the Changes made in Bodies must arise only from the various Separations, new Conjunctions and Motions of these original Particles. For mix'd or compounded Bodies are broken or destroyed, not by the breaking to Pieces of their solid original Particles, but by separating them one from another, and disposing them in those Places where they touch'd one another but in a little Part of their Surface. And these Original Particles, seem not only to have in them the *Vis inertiae* and all those *Passive Laws of Motion* which necessarily arise from thence; but receive also *Motion continually* from certain *Active Principles*; *viz.* such as *Gravity*, the *Cause of Fermentation* and of the *Cohesion* of the Parts of *Matter*. And these Principles are not to be considered as *occult Qualities* which are feigned to arise from the *Specifick Forms* of Things, but as the *Universal Laws of Nature* by which Things themselves are formed. For that there are really such Principles,



*Principles*, the various Phænomena of Nature do demonstrate, tho' what their Causes are hath not yet been explain'd: For to assert that the *several Species* of Things are endued with *Specifick Occult Qualities*, by which they have a certain Force or Power in acting, is in Reality to say Nothing. But from the Phænomena of Nature to derive two or three *general Principles of Motion*, and from thence to explain how the Properties and Actions of all Corporeal Things may be deduced from those Principles, would be a very great Progress in Natural Philosophy, although the Causes of those Principles should be yet undiscovered.

NAVE, in Architecture, signifies the main Body of a Church.

NAVEL-STRING. See *Umbilical Vessels*.

NAVIGATION. Books on this Subject are;

Sir Jonas Moor, in 2 Vol. in Quarto.

Wright's *Correct Errors in Navigation*.

Norwood's *Epitome of the Art of Navigation*.

Sturmy's *Mariners Magazine*.

Seller's *Practical Navigation*.

Norwood's *System of His Seaman's Practice*.

of Navigation } — Companion.

Phillips's *Geometrical Seaman*.

Colson's *Calendar*.

Martin's *Art of Navigation*.

Perkin's *Seaman's Tutor*.

Eden's *Art of Navigation*.

Tresor de Navigation par M. Blondell.

Collin's *Plain Scale new plained*.

Jones's *Navigation*.

Newton's *Idea of Navigation and Geography*.

Atkinson's *Epitome of Navigation*.

Hodgson's *Theory of Navigation demonstrated*. 4to. 1707.

NAVICULARE Os, called also *Cymbiforme*, is the third Bone in each Foot, in that Part of it which immediately succeeds the Leg.

NAVIGATION, is the Art of *Sailing*, whereby the Mariner is instructed how to guide a Ship from one Port to another, the shortest and safest way, and in the shortest Time: And this is twofold; either

*Improper*, Which is called *Coasting*, in which the Places are at no great distance one from another, and the Ship sails usually in sight of Land, and is within Soundings. Now for the Performance of this, there is required a good Knowledge of the Lands, the Use of the Compass, the Lead, or Sounding-Line, and such Books as *Rutter's*, &c.

*Navigation Proper*, is where the Voyage is perform'd in the vast Ocean, out of sight of all Land; and here is necessary not only the Knowledge of the *Lead*, *Compass*, &c. but the Master must be a thro' *Sailor* or *Artist*, and understand well *Mercator's Charts*, *Azimuth* and *Amplitude Compass*, *Log-Line*, and all good Instruments for *Celestial Observations* that can be used at *Sea*. And how to perform the several Parts and Cases of this Art, you will find under the Word *Plain*, and *Mercator's Sailing*.

NAUSEA [in *Medicine*] is defin'd Anatomically by *Boerhaave*, to be a retrograde spasmodick Motion of the musculous Fibres of the Oesophagus, Stomach, and Interiors, attended with Convulsion of the abdominal Muscles, and the *Septum Transversum*; it is also defin'd to be a Retching or Propensity, and endeavour to Vomit; arising from a loathing of Food, excited by some viscus Humour that irritates the Stomach, and urges it thus to discharge itself; or a *Nausea* is when the

Thoughts or Sight of proper Food cause a Sickness in the Stomach or a Tendency to Vomit. L  
NAUSEOUSNESS, or *Nausea*, Loathing, is an earnest Endeavour to Vomit, with Sickness and Uneasiness.

NAUTICAL Chart. See *Chart*.

NAUTICAL Compass. See *Compass*.

NAUTICAL Planisphere, is a Description of the Terrestrial Globe upon a Plane, for the Use of Mariners; and is either,

1. The *Plane Chart*, as they call it, where the *Parallels of Latitude* are all of the same Length with the *Meridians*; and which therefore is very erroneous, except in short Voyages, and near the Equator: Or,

2. *Wright's*, commonly called *Mercator's Chart*, where the *Meridians* are increased in Proportion, as the *Parallels* shorten: That is, as the Secants of the Arks contained between the Point of Latitude, and the Equator.

NAUTILUS [in natural History,] a petrified Shell found in the Earth, in other respects like those found in the Sea or Rivers.

NE Admittas, is a Writ directed to the Bishop, at the Suit of one who is Patron of any Church, and he doubts that the Bishop will Collate on his Clerk, or admit another Clerk presented by another Man to the same Benefice: Then he that doubts it, shall have this Writ, to forbid the Bishop to Collate or Admit any to that Church.

NEALING of *Glass*, is the Baking of it to dry, harden and give it the due Consistence, after it has been blown and fashioned into its proper form; also for the staining Glass with Metal Colours.

NEALING of *Steel*, is heating of it in the Fire to a *Blood-red-heat*, and then taking it out and letting it cool gently of it self. This is done to make it softer, in order to engrave or punch upon it.

NEAR, at Sea, when the Conner commands the Man at the Helm to set the Ship full to Leeward, his Word is *No near*.

NEAP-TIDES are those Tides in the second and fourth Quarter of the Moon, which are low Tides in Comparison to those of the Spring.

NEBULOSE, a Term in Heraldry, when the out-Line of any Bordure, Ordinary, &c. is of this Form, *i. e.* resembling something of the Figure of Clouds.



NEBULOUS Stars, are certain fixed Stars of a dull, pale, and obscurish Light.

NEBULOUS-Stars, seen through good Telescopes appear to be Clusters of small Stars: as appears by the Observations of *Cassini* and *Flamsteed*. See *Philos. Transf. N. 123*.

NECROLOGY [*Νεκρολογία* of νεκρος dead and λόγος, Gr.] a Book antiently kept in Churches and Monasteries in which they registred the Names of their Benefactors, the Times when they died, and the Days of their Commemoration.

NECROMANCY [*Νεκρομαντεία* of νεκρος and μαντεία, Gr. Divination] the Act or Art of communicating with the Spirits of the Dead, or rather with Devils, by calling up the Dead, and doing surprising Feats by their assistance.



NECROSIS, is a black and blue Mark in any part of the Body.

NECYDALUS, the same with *Nympha*, a Term used in the Natural History of *Insects*. See *Nympha*.

NEEDLE. See *Box* and *Needle*.

NEGATIVE *Pregnant*, is when an Action, Information, or such like, is brought against one, and the Defendant Pleads in Bar of the Action; or otherwise a *Negative Plea*, which is not so special an Answer to the Action, but that it includes also an Affirmative: As if a Man being impleaded to have done a thing on such a Day, or in such a Place, denieth that he did it *Modo & forma declamata*; which implieth nevertheless, That in some sort he did it: Or, if a Man be said to have alienated Land in Fee, and he saith, he hath not alienated in Fee, this is *Negative Pregnant*; for though it be true, that he hath not alienated in Fee, yet it may be, he hath made an Estate in Taile.

NEGATIVE Quantities in *Algebra*, are such as have before them the

NEGATIVE Sign —, and which is supposed to be less than nothing. These are directly contrary to Positive, Affirmative, or Real Quantities.

NEIFE, *Nativa*; is a Bond-woman, *An. 1 E. 6. 3. and 9 R. 2. cap. 2.* But if she married a Freeman she was thereby made free; and when once made free and discharged of all Bondage cannot be *Neife* after, without some special Act done by her; as Divorce or Confession in a Court of Record. Nor shall a Free-woman be bound by taking a Villain to her Husband; but their Issue shall be Villains after their Father. There was also anciently a *Writ of Neifty*, whereby the Lord claim'd his *Neife*; but all this is now out of Doors.

NE *injuste vexes*, is a Writ which lies for a Tenant that is Distrained by his Lord for other Services than he ought to make, and is a Prohibition to the Lord in it self, commanding him not to Distrain.

NEIP TIDES, written also *Nepe* or *Neep*, are those Tides (when the Moon is in the middle of the second and last Quarter) which are opposite to the *Spring-Tides*; and as the highest of the *Spring-Tides* is three Days after the Full or Change, so the lowest of the *Neep* is four Days before the Full or Change; and then the Seamen say, that it is *Deep Neep*: Also when a Ship wants Water, so that she cannot get out of a Harbour, off from the Ground, or out of the Dock, the Seamen say she is *Neiped*.

NEOMENIUM, signifies only the *New Moon*, or *Change*.

NEPER's Bones, or Rods, are a kind of larger Multiplication Table, contrived by that Excellent Mathematician my Lord Neper, Baron of *Merchiston* in *Scotland*, for the more easy multiplying, dividing, and extracting of Roots out of great Numbers.

Their Fabrick is very easy, as well as their Use: Both which follow.

The Rods are best made of Wood or Ivory, four Square, having all the Digits on them, and their Multiplication to 9; being only *Pythagoras's* Table cut into pieces; they have an Index prefixed, shewing the Value of the Multiples to 9. The Complement, *viz.* Remainder to 9, is on the back-side of each Bone, the other Sides being disposed in the most convenient form, the Figures represented being set on the Ends: But they are so common, and so well known, that there needs no further Description of them.

The INDEX.

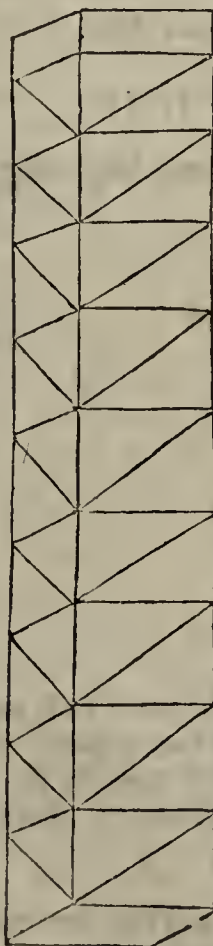
1	6	1	2	3	6123
2	12	2	4	6	12246
3	18	3	6	9	18369
4	24	4	8	12	24492
5	30	5	10	15	30615
6	36	6	12	18	36738
7	42	7	14	21	42861
8	48	8	16	24	48984
9	54	9	18	27	55107

Having any given Number to Tabulate, or to be laid down by the Rods: As suppose 6123.

From your Set of Rods, take as many of them as you have Numbers in your Figures, as here 4 Rods, having at the top of them the given Figures, which set in their respective Order as above; and the Product of the whole given Number into any of the Digits, you have right against that Digit, as the Index directs, taking the Sum of every Diagonal Square, and setting them down from the Right to the Left.

To Multiply by the Rods.

A Single ROD.



Set your Multiplicand down, or Tabulate it on the Rods, and take every several Product answering the Figures of your Multiplier; which, all added together, gives the Product: As if 6123 was to be multiplied by 356, having Tabulated the Multiplicand, (as you see above) the several Products thereof into each Figure of the Multiplier, you are directed to by the Index: Which being added together, (respect being had to the due placing, their Sum) is 2179788, which is the Product of 6123 by 356.

$$\begin{array}{r}
 6123 \\
 356 \\
 \hline
 36738 \\
 30615 \\
 18369 \\
 \hline
 2179788
 \end{array}$$

Division by Neper's Bones.

Tabulate your Divisor, then you have it multiplied by all the Digits; out of which you may chuse such convenient Divisors as will be next to the Figures in the Dividend, and sub-



scribe the Index answering in the Quotient; and so continually, till the Work is done. Thus 2179788, divided by 6123, gives in the Quotient 356.

Having Tabulated the Divisor 6123, then I see that 6123 cannot be had in 2179; therefore I take five Places, and on the Rods find a Number that is equal or next less to 21797, which is 18369, that is three times the Divisor: I set 3 in the Quotient, and subtract 18369 from the Figures above, there rests 3428; to which I add 8, the next Figure of the Dividend, and seek again on the Rods for it, or the next less, which I find to be 5 times; I set 5 in the Quotient, and subtract 30615 from 34288, rests 3673; to which I add 8, the last Figure in the Dividend, and finding it to be 6 times the Divisor, set 6 in the Quotient.

$$\begin{array}{r}
 6123 \ ) \ 2179788 \ ( \ 356 \\
 \underline{18369} \phantom{00} \\
 34288 \\
 \underline{30615} \phantom{00} \\
 36738 \\
 \underline{36738} \phantom{00} \\
 00000
 \end{array}$$

*Of the Extraction of Roots by the Rods.*

For the easy and expeditious Performance of which, there are two Rods on Purpose; one for the Square, and another for the Cube.

*To Extract the Square Root.*

[As, suppose that of 571536.

First, Point each other Figure, beginning with the last.

$$\begin{array}{r}
 \phantom{000} 571536 \ ( \ 756 \\
 \underline{49} \phantom{00} \\
 145 \ ) \ 815 \\
 \underline{725} \phantom{00} \\
 1506 \ ) \ 9036 \\
 \underline{9036} \phantom{00} \\
 0000
 \end{array}$$

2. Take the Rod, called the Square Rod, and set it to the Index, and seek for the Figures of the first Prick (57,) finding 49 the nearest, set 7 in the Quotient, and subtract 49 from 57, there rests 8.

3. To the Remainder (8) add the next two Figures to the next Prick (15) makes 815.

4. Double the Quotient 7, viz. 14, which Tabulate between the Index and the Square Rod each time after the Work; seek them upon the Rods for the next less or equal Number to the Figures 815, which I find to be 725, that is five times;

set 5 in the Quotient, and after the Divisor; then multiply and subtract, and to the Remainder add the two Places to the next Point 36.

5. Double the Quotient 75, which is 150; this set betwixt the Index and the Square Rod, and work as before, you'll find the Root to be 756.

If your Root be not perfect, but something remains after the last Subtraction, add a Cypher to the Square, and proceed.

*To Extract the Cube Root by the Rods.*

$$\begin{array}{r}
 \phantom{000} 91733851 \ (451 \\
 \underline{64} \phantom{00} \\
 48 \ ) \ 27733 \\
 \underline{24125} \phantom{00} \\
 300 \phantom{00} \\
 6075 \ ) \ 608851 \\
 \underline{607501} \phantom{00} \\
 135 \phantom{00} \\
 608851
 \end{array}$$

1. Point every third Figure from the last, set the Cube Rod to the Index; seek the next less Cube on the Rod, which in the foregoing Example is 64, that is 4 times; set 4 in the Quote, and subtract, rest 27; to which add the three Figures to the next Point, the Sum is 27733.

2. Square the Figure found in the Quotient, and triple that Square, (and this must be done each time for a Divisor) which set betwixt the Index and the Cube Rod: Thus here the 4 in the Quote, squar'd, gives 16; then tripled is 48, which set between the Index and the Cube Rod for a Divisor.

3. Seek a Quotient (5) which set down, and the Number answering 24125 place as in the Example; but before you subtract, you must triple the Quote 4, which is 12, and multiply it by the Square of the last Figure 5. viz. 25; now 25 by 12 = 300, which place under 24125, one place forward to the Left Hand, and subtract there rests 608. This Work must be repeated for each Figure in the Quotient, viz. to 608 and 851 for a Resolvend; square 45, and triple that Square, it gives 6075 for a new Divisor, which placed next before the Cube Rod, shews it will be but 1 for the Quotient, which answers to 607501, which set down; and tripling 45, and multiplying it by 1, makes 135: This set one short, their Sum will be 608851; so that after Subtraction nothing remains. But if there remains any thing, add three Cyphers to it, for every Decimal Place you would have in the Root, and proceed as before.

NEPHELÆ, are small White Spots upon the Eyes; also little Clouds, as it were, that swim in the middle of the Urine; likewise little white Spots in the Surface of the Nails like little Clouds.



NEPHRITICKS, [*νεφριτικὰ* Gr.] are Medicines against the Diseases of the Reins.

NEPHRITIS, is a [*νεφρίτις* Gr.] Pain in the Reins, proceeding either from an ill Disposition, or an Inflammation, or from the Stone and Gravel, accompanied with Vomiting and Stretching of the Thigh. *Blanchard*

NEPHROS, [*νεφρός* Gr.] is a Kidney, one on each side of the *Abdomen*, placed about the Loins under the Liver and Spleen; it is shaped like a Kidney-Bean: Its Substance is made up of a great Company of little Pipes. On both sides it receives the *Serum* from the Glandules which border upon the Arteries, and carries it to the little Bodies in the Reins called *Carunculæ Papillares*, (which see) that so it may be discharged by the *Pelvis*, the *Ureters*, the *Bladder*, &c. See *Reines*.

NERVE, is an Organical Similar Part of an Human Body, being also of a fibrous round, long, white, porous Substance, and whose Use is to convey the Animal Spirits so, as to make the Parts of the Body moveable and sensible.

The Nerves are supposed to contain a Three-fold-Substance; the innermost of which is white and medullary, and is thought to proceed from the *Medulla Cerebri*; the other two are supposed to arise from the *Meninges* of the Brain: Of which the middle and softer comes from the *Pia mater*, and the outer and harder from the *Dura mater*.

All the Nerves take their Rise from the *Medulla oblongata cerebri*, either within the Skull, or from its Continuation, when it becomes the *Medulla spinalis*. *Diemerbroeck* reckons 39 Pairs or Conjugations of Nerves, besides the *Nervus sine pari*; and he reckons that nine Pair of these arise within the Skull, and the other 30 he saith come from the *Medulla spinalis*, through the Perforations of the *Vertebrae*; which he subdivides into the eight *Cervical Pairs*, the Twelve *Thoracical*, the five that come from the Region of the Loins, and the other five which come from the *Os sacrum*; to which the *Nervus sine pari* is to be added, which arises from the End of the Spinal Marrow, and which some have taken for a kind of Ligament.

The Nerves do ordinarily accompany the Arteries through all the Body, that by the Pulse of the Arteries, the Animal Spirits may be kept warm and moving.

The Nerves have also Blood-Vessels attending them, which are spread usually on their Coats; and do also sometimes run in among the Medullary Fibres, as may be seen in those of the *Retina*.

Where-ever a Nerve sends out a Branch, or receives one from another, there is commonly a *Ganglio* or *Plexus*, as you may see at the Origin of all the Nerves in the *Medulla spinalis*, and in many Places of the Body.

NERVES [in *Architecture*] are the Mouldings of projecting Arches of Vaults; or those which arrive from the Branches of Ogives, and cross each other diagonally in *Gothick* Vaults, and serve to separate the Pendentives.

NERVOUS Spirit [in *Physick*] is a pure, subtile, volatile Humour, call'd also the Animal Spirit; which is secreted from the arterious Part of the Blood in the cortical Part of the Brain, collected in the *medulla oblongata*, and driven thence by the Force of the Heart into the Cavities of the Nerves, to be by them convey'd throughout the Body, for the purposes of Sensation and Animal Motion.

NERVUS, in Botanicks, signifies a long Filament or rigid String, which runs across or length ways in the Leaf of a Plant. And thus, because there are five such Nerves or Filaments running long ways in the Leaves of one kind of *Plantane*, that Plant hath been called *Quinque nerva*.

NETE *Hyperboleon* [*νητη ὑπερβολέων* Gr. i. e. the last of the highest Chords] the highest and most acute of the Chords of the Lyre, or the ancient Scale or Diagramma, it answers to *a*, *mi*, *la*, of the third Octave of the Organ or the modern System.

NETE *Diezeugmenon* [of *νητη* and *διαζευγμένον* Gr.] the last of the separate ones, one of the ancient Chords of the Lyre, answering to the *e*, *fi*, *mi*, of the third Octave of the Organ or modern System.

NETE *Synemmenon* [*νητη συνεμμένον*, the last Chord of those added] the highest Chord of a tetrachord of the ancient *Greek* System added to make the *b* soft of all between the *Mese* and *Paramese*, i. e. between *la* and *fi*.

NETTINGS, in a Ship, are a sort of Grate made with small Ropes, and seized together with Rope-yarn; and are laid in the Waste of a Ship sometimes, to serve instead of *Gratings*.

NEURODES, [of *νεῦρον* Gr.] is a sort of lingering Fever, so called by the Learned Dr. *Willis*; because that the Nervous Juice, departing from its own right and natural Crasis, becomes the Occasion of an *Atrophy*.

NEUROGRAPHY [of *νευρογραφία* of *νεῦρον* and *γράφω* Gr. to write] a Treatise or Description of the Nerves.

NEUROLOGY, [*νευρολογία* Gr.] is an accurate Description of, or Discourse on, the Nerves of an Human Body.

NEUROTICKS [*νευροτικά* of *νεῦρον* Gr.] are Remedies against the Diseases of the Nerves.

NEUROTOMY, [*νευροτομία* of *νεῦρον* and *τεμνω* Gr. to Cut] is an Anatomical Section of the Nerves, for the Benefit of the Patient; and sometimes also a pricking of the Nerves by unskilful Bleeding, &c.

NEUTER [in *Grammar*] a sort of Gender of Nouns, which are neither Masculine nor Feminine.

NEUTRAL. Mr. *Boyle* calls some kind of Spirits which he could distil from Tartar, and some ponderous Woods, by this Name of *Neutral Spirits*, as also *Adiaphorous* and *Anonymous*; because he found them very different in Quality and Nature from either the *Acid*, *Vinous*, or *Urinous* Spirits. For the Way of making it, see *Adiaphorous*.

NEUTRAL Salts [in *Chymistry*] are a sort of intermediate Salts, between Acids and Alkalies; which partake of the Nature of both.

NEWEL, in *Architecture*, is the upright Post that the Case of winding Stairs turns round about.

NEWTONIAN Philosophy, the Doctrine of the Universe, and particularly of the Heavenly Bodies; their Laws, Affections, &c. as deliver'd by Sir *Isaac Newton*.

The Term *Newtonian* Philosophy, is apply'd very differently; whence divers confused Notions relating thereto.

Some Authors, under this Philosophy, include all the Corpuscular Philosophy consider'd as it now stands corrected and reform'd by the Discoveries and Improvements made in several Parts thereof, by Sir *Isaac Newton*. In this Sense it is that *Gravescand*



*vesandt* calls his Elements of Physicks, *Introductio ad Philosophiam Newtonianam*.

And in this Sense the *Newtonian* is the same with the New Philosophy, and stands contradistinguished to the Cartesian, the Peripatetic, and the antient Corpuscular.

Others by *Newtonian* Philosophy, mean the Method or Order which Sir *Isaac Newton* observes in Philosophizing, viz. the Reasoning, and drawing of Conclusions directly from Phænomena, exclusive of all previous Hypotheses; beginning from simple Principles; deducing the first Powers and Laws of Nature from a few select Phænomena, and then applying those Laws, &c. to account for other things. To this Purpose, the same *Gravesandt* explains himself in his *Institut. Newton. Philos.*

And in this Sense, the *Newtonian* Philosophy is the same with the Experimental Philosophy; and stands opposed to the antient Corpuscular.

Others, by *Newtonian* Philosophy, mean that wherein Physical Bodies are consider'd Mathematically; and where Geometry and Mechanicks are apply'd to the Solution of Phænomena; in which Sense, the *Newtonian* is the same with the mechanical and mathematical Philosophy.

Others again, by *Newtonian* Philosophy, understand that part of physical Knowledge, which Sir *Isaac Newton* has handled, improved, and demonstrated, in his *Principia*.

Others, lastly, by *Newtonian* Philosophy, mean, the new Principles which Sir *Isaac Newton* has brought into Philosophy; the new System founded thereon; and the new Solution of Phænomena thence deduced; or that which characterizes, and distinguishes his Philosophy from all others, which is the Sense wherein we shall here chiefly consider it.

As to the History of this Philosophy, we have but little to say; it was first made publick in the year 1686, by the Author, then a Fellow of *Trinity College, Cambridge*; and in the Year 1713, republished with considerable Improvements. Several other Authors have since attempted to make it plainer; by setting aside many of the more sublime mathematical Researches, and substituting either more obvious Reasonings, or Experiments, in lieu thereof; particularly *Whiston* in his *Prælect. Phys. Mathemat.* and *Gravesandt*, in *Element. & Institut.* Notwithstanding the great Merit of this Philosophy, and the universal Reception it hath met with at home, it gains ground very slowly abroad; *Newtonianism* has scarce two or three Adherents in a Nation; but *Cartesianism*, *Huygenianism*, and *Leibnitzianism* remain still in Possession.

The Philosophy itself is laid down chiefly in the third Book of the *Principia*, the two preceding Books are taken up in preparing the way, and laying down such Principles of Mathematicks as have the most relation to Philosophy; such are the Laws and Conditions of Powers; and these, to render them less dry and geometrical, the Author illustrates by Scholia in Philosophy, relating chiefly to the Density and Resistance of Bodies, the Motion of Light and Sounds, a Vacuum, &c.

In the third Book he proceeds to the Philosophy itself; and from the same Principles deduces the Structure of the Universe, and the Powers of Gravity, whereby Bodies tend towards the Sun and Planets; and from these Powers, the Motions of the Planets and Comets, the Theory of the Moon and the Tides. This Book, which he calls *de Mundi Systemate*, he tells us, was first wrote in the

popular way; but considering, that such as are unacquainted with the said Principles, would not conceive the Force of the Consequences, nor be induced to lay aside their antient Prejudices; for this Reason, and to prevent the thing from being in continual Dispute, he digested the Sum of that Book into Propositions, in the Mathematical Manner; so as it might only come to be read by such as had first consider'd the Principles; not that it is necessary, a Man should Master them all, many of them, even the first rate Mathematicians would find a Difficulty in getting over. 'Tis enough to have read the Definitions, Laws of Motion, and the three first Sections of the first Book; after which, the Author himself directs us to pass on to the Book *de Systemate Mundi*. The several Articles of this Philosophy, are deliver'd under their respective Heads in this Dictionary; as *Sun, Moon, Planet, Comet, Earth, Air, Centripetal Force, Resistance, Medium, Matter, Space, Elasticity*, &c. A general Idea or Abstract of the whole, we shall here gratify the Reader withal; to shew in what Relation the several Parts stand to each other.

The great Principle on which the whole Philosophy is founded, is the Power of Gravity. This Principle is not new; *Kepler*, long ago, hinted it in his *Introduct. ad Mot. Martis*. He even discovered some of the Properties thereof, and their Effects in the Motions of the primary Planets; but the Glory of bringing it to a Physical Demonstration was reserved to the *English* Philosopher.

His Proof of the Principle from Phænomena, together with the Application of the same Principle to the various other Appearances of Nature, or the deducing those Appearances from that Principle, constitute the *Newtonian* System; which, drawn in Miniature, will stand thus,

1. The Phænomena are, 1. That the Satellites of *Jupiter* do, by Radii drawn to the Centre of the Planet, describe Areas proportional to their Times; and that their periodical Times are in a sesquiplicate Ratio of their Distances from its Centre; in which all Observations of all Astronomers agree. 2. The same Phænomenon holds of the Satellites of *Saturn*, with regard to *Saturn*; and of the *Moon* with regard to the *Earth*. 3. The periodical Times of the primary Planets about the *Sun*, are in a sesquiplicate Ratio of their mean Distances from the *Sun*. But, 4. The primary Planets do not describe Areas any way proportional to their periodical Times, about the *Earth*; as being sometimes seen Stationary, and sometimes Retrograde with regard thereto.

2. The Powers whereby the Satellites of *Jupiter* are constantly drawn out of their rectilinear Course, and retain'd in their Orbits, do respect the Center of *Jupiter*, and are reciprocally as the Squares of their Distances from the same Center. 2. The same holds of the Satellites of *Saturn* with regard to *Saturn*; of the *Moon* with regard to the *Earth*; and of the primary Planets with regard to the *Sun*.

3. The *Moon* gravitates towards the *Earth*, and by the Power of that Gravity is retain'd in her Orbit; and the same holds of the other Satellites with respect to their primary Planets; and of the Primaries with respect to the *Sun*.

As to the *Moon*, the Proposition is thus proved. The *Moon's* mean Distance is 60 Semidiameters of the *Earth*; her Period, with regard to the fix'd Stars, is 27 Days, 7 Hours, 43 Minutes; and the

Earth's



Earth's Circumference 123249600 *Paris* Feet. Now, supposing the Moon to have lost all its Motion, and to be let drop to the Earth, with the Power which retains her in her Orbit; in the Space of one Minute she will fall  $15 \frac{1}{12}$  *Paris* Feet; the Arch she describes in her mean Motion at the Distance of 60 Semidiameters of the Earth being the versed Sine of  $15 \frac{1}{12}$  *Paris* Feet. Hence, as the Power as it approaches the Earth, increases in a duplicate Ratio of the Distance inversely; so, as at the Surface of the Earth, 'tis  $60 \times 60$  greater than the Moon; a Body falling with that Force in our Region, must in a Minutes time, describe the Space of  $60 \times 60 \times 15 \frac{1}{12}$  *Paris* Feet, and  $15 \frac{1}{12}$  *Paris* Feet in the Space of one Second.

But this is the Rate at which Bodies fall by their Gravity at the Surface of our Earth; as *Huygens* has demonstrated by Experiments with Pendulums. Consequently, the Power whereby the Moon is retained in her Orbit, is the very same we call Gravity; for if they were different, a Body falling with both Powers together, would descend with double the Velocity, and in a Second of Time describe  $30 \frac{1}{2}$  Feet.

As to the other secondary Planets, their Phænomena with respect to their primary ones, being of the same kind with those of the Moon about the Earth; 'tis argued by Analogy, they depend on the same Causes; it being a Rule or Axiom all Philosophers agree to, that Effects of the same kind have the same Causes. Again, Attraction is always Mutual, *i. e.* the Reaction is equal to the Action, consequently, the primary Planets gravitate towards their secondary ones; the Earth towards the Moon, and the Sun towards them all. And this Gravity, with regard to each several Planet, is reciprocally as the Square of its Distance from its Centre of Gravity.

4. All Bodies gravitate towards all the Planets; and their Weight towards any one Planet, at equal distances from the Centre of the Planet, are proportional to the Quantity of Matter in each.

For the Law of the Descent of heavy Bodies towards the Earth, setting aside their unequal Retardation from the Resistance of the Air is this; that all Bodies fall equal Spaces in equal Times; but the nature of Gravity or Weight, no doubt, is the same on the other Planets as on the Earth.

Suppose, *e. gr.* such Bodies raised to the Surface of the Moon, and together with the Moon deprived at once of all progressive Motion, and drop'd towards the Earth; 'Tis shewn, that in equal Times they will describe equal Spaces with the Moon; and therefore, that their Quantity of Matter is to that of the Moon, as their Weights to its Weight.

Add, that since Jupiter's Satellites revolve in Times that are in a sesquiplicate Ratio of their Distances from the Centre of Jupiter, and consequently at equal Distances from Jupiter their accelerating Gravities are equal; therefore falling equal Altitudes in equal Times, they will describe equal Spaces; just as in heavy Bodies on our Earth. And the same Argument will hold of the primary Planets with regard to the Sun, and the Powers whereby unequal Bodies are equally accelerated, are as the Bodies, *i. e.* the Weights are as the Quantities of Matter in the Planets, and the Weights of the primary and secondary Planets towards the Sun, are as the Quantities of Matter in the Planets and Satellites.

And hence are several Corollaries drawn relating to the Weights of Bodies on the Surface of the

Earth, Magnetism, and the Existence of a Vacuum.

5. Gravity extends itself towards all Bodies, and is in proportion to the Quantity of Matter in each.

That all the Planets gravitate towards each other, has been already shewn; likewise, that the Gravity towards any one consider'd apart, is reciprocally as the Squares of its Distance from the Centre of the Planet; consequently, Gravity is proportional to the Matter therein. Further, as all the Parts of any Planet, A, gravitate toward another Planet B; and the Gravity of any Part is to the Gravity of the whole, as the Matter of the Part to the Matter of the whole; and Reaction equal to Action: The Planet B will gravitate towards all the Parts of the Planet A; and its Gravity towards any part will be to its Gravity towards the whole, as the Matter of the Part to the Matter of the whole.

Hence, we derive the Methods of finding and comparing the Weights of Bodies towards different Planets; of finding the Quantity of Matter in the several Planets, and their Densities; since the Weights of equal Bodies revolving about Planets, are as the Diameters of their Orbits directly, and as the Squares of the periodical Times inversely; and the Weights at any Distance from the Centre of the Planet are greater or less in a duplicate Ratio of their Distances inversely. And since the Quantities of Matter in the Planets are as their Powers at equal Distances from their Centres: And lastly, since the Weights of equal and homogeneous Bodies towards homogeneous Spheres, are, at the Surfaces of the Spheres, as the Diameters of those Spheres; and consequently, the Densities of heterogeneous Bodies are as the Weights at the Diameters of the Spheres.

6. The common Centre of Gravity of the Sun, and all the Planets is at rest; and the Sun, though always in Motion, yet never recedes far from the common Centre of all the Planets.

For the Matter in the Sun being to that in Jupiter as 1033 to 1; and Jupiter's distance from the Sun to the Semidiameter of the Sun in a Ratio somewhat bigger; the common Centre of Gravity of Jupiter and the Sun, will be a Point a little without the Sun's Surface, and by the same means the common Centre of Saturn, and the Sun, will be a Point a little within the Sun's Surface; and the common Centre of the Earth, and all the Planets, will be scarce one Diameter of the Sun distant from the Centre thereof; but the Centre is always at rest. Therefore, though the Sun will have a Motion this and that way, according to the various Situations of the Planets, yet it can never recede far from the Centre; so that the common Centre of Gravity of the Earth, Sun and Planets, may be esteemed the Centre of the whole World.

7. The Planets move in Ellipses that have their Foci in the Centre of the Sun; and describe Areas proportional to their times.

This we have already laid down *à posteriori*, as a Phænomenon; and now, that the Principle of the heavenly Motions is shewn, we deduce it therefrom *à priori*. Thus, since the Weights of the Planets towards the Sun are reciprocally as the Squares of their distances from the Centre of the Sun; if the Sun were at rest, and the other Planets did not act on each other, their Orbits would be Elliptical, having the Sun in the common Umbilicus, and would describe Areas proportional to the Times; but the mutual Actions of the Planets are very small, and may be well thrown aside.



Indeed, the Action of Jupiter on Saturn is of some consequence; and hence, according to the different Situations and Distances of those two Planets, their Orbits will be a little disturbed. The Sun's Orbit too, is sensibly disturbed by the Action of the Moon; and the common Centre of the two describes an Ellipsis round the Sun placed in the Umbilicus; and with a Radius drawn to the Centre of the Sun, describes Areas proportional to the Times.

8. The Aphelia and Nodes of the Planets are at rest, excepting for some inconsiderable Irregularities arising from the Actions of the revolving Planets and Comets. Consequently, as the fix'd Stars retain their Position to the Aphelia and Nodes; they too are at rest.

9. The Axis, or Polar Diameter of the Planets, is less than the Equatorial Diameter.

The Planets, had they no diurnal Rotation, would be Spheres; as having an equal Gravity on every side: But by this Rotation, the Parts receding from the Axis, endeavour to rise towards the Equator, which, if the Matter they consist of be fluid, will be affected very sensibly. Accordingly Jupiter, whose Density is found not much to exceed that of Water on our Globe, is observed by the Astronomers to be considerably less between the Poles, than from East to West. And on the same Principle, unless our Earth were higher at the Equator than towards the Poles, the Sea would rise under the Equator and overflow all near it. But this Figure of the Earth, Sir Isaac Newton proves likewise *à posteriori*; from the Oscillations of Pendulums being slower and smaller in the Equatorial, than the polar Parts of the Globe.

10. All the Moon's Motions, and all the Inequalities in those Motions, follow from these Principles, *e. gr.* her unequal Velocity, and that of her Nodes and Apogee in the Syzygies and Quadratures; the Differences in her Eccentricity, and her Variation, &c. See Moon, Quadrature, Syzygy, &c.

11. From the Inequalities in the Lunar Motions, we can deduce the several Inequalities in the Motions of the Satellites.

12. From these Principles, particularly the Action of the Sun and Moon upon the Earth, it follows, that we must have Tides, or that the Sea must swell and subside twice every Day.

13. Hence likewise follows the whole Theory of Comets; as, that they are above the Region of the Moon, and in the planetary Spaces; that they shine by the Sun's Light reflected from them; that they move in Conic Sections, whose Umbilici are in the Centre of the Sun; and by Radii drawn to the Sun, describe Areas proportional to the Times; that the Orbits or Trajectories are very nearly Parabolas; that their Bodies are solid, compact, &c. like those of the Planets, and must therefore acquire an immense heat in their Perihelia; that their Tails are Exhalations arising from them, and encompassing them like Atmospheres. The Objections rais'd against this Philosophy, are chiefly against the Principle Gravity; which some condemn as an occult Quality, and others as a miraculous, and præternatural Cause; neither of which have any longer room in the sound Philosophy; others again, set it aside as destroying the Notion of Vortices; and others, as supposing a Vacuum. But these are all abundantly obviated under the Articles, Gravity, Attraction, Vortex, Vacuum, Quality, &c.

NICHE, in Architecture, is a Cavity left designedly in the Wall of a Building, to place a Statue in.

Round NICHE is one whose Plain and Circumference are circular.

Square NICHE one which is Square.

Angular NICHE one that is formed in the corner of a Building.

Ground NICHE one which instead of bearing on a Massive has its rise from the Ground.

NICTITANS *Membrana*, is a thin Purplish or Reddish Membrane or Film, which several Beasts and Birds have to cover or shield their Eyes from Dust, &c. they can draw it over their Eyes at pleasure, and 'tis so very much thinner than the Eye-lid, that they can see pretty well through it.

NIENT *comprise*, is an Exception taken to a Petition, as unjust, because the thing desired is not contained in that Act or Deed, whereon the Petition is grounded. For Example, One desireth of the Court to be put into Possession of a House, formerly amongst other Lands, &c. adjudged unto him: The adverse Party pleadeth, That this Petition is not to be granted, because though he had a Judgment for certain Lands and Houses, yet the House, into the Possession whereof he desireth to be put, is not contained amongst those for which he had Judgment.

NIHIL, or *Nichil*, is a Word which the Sheriff answers, that is opposed concerning Debts illeivable, and that are nothing worth, by reason of the insufficiency of the Parties from whom they are due.

NIHIL *dicit*, is a failing to put in Answer to the Plea of the Plaintiff by the Day assigned; which if a Man omit, Judgment passeth against him of Course by *Nihil dicit*; that is, because he says nothing in his own Defence, why it should not.

*Nihil capiat per Breve*, is the Judgment given against the Plaintiff, either in Bar of his Action, or in Abatement of his Writ.

*Nihil capiat per Billam*, the same with *Nihil capiat per Breve*.

NIPPERS, are small Ropes in a Ship about a Fathom or two long, with a little Truck at one End, and sometimes only a Wale-knot; their Use is to help *hold off* the Cable from the Main or Jeer Capstan, when the Cable is so slimy, so wet, or so great, that they cannot strain it to *hold it off* with their bare Hands.

NISI *Prius*, is a Writ Judicial, which lieth in Case, where the Jury is Impannel'd, and return'd before the Justices, the one Party or the other requesting to have this Writ for the ease of the Country, whereby the Sheriff is willed to cause the Inquest to come before the Justices in the same County at their coming; and it is called a Writ of the *Nisi prius*, of these two Words, whereby the Sheriff is commanded to bring to *Westminster* the Men Impannel'd at a certain Day, or before the Justices of the next Assizes, *Nisi die Lunæ apud talem locum prius venerint*, &c.

NITRE, the same with Salt Petre. Some are mighty fond of the Notion of a *Volatile Nitre*, which abounds in the Air; and they attribute abundance of *Phænomena* to the Operation of the Nitrous Particles in the Air.

That the Air abounds with Saline Particles, is most certain; for being filled continually with *Effluvia* from the Earth and Sea, it must needs have



have from both a great Quantity of Saline Corpufcles; and thefe will be of different Kinds according to the Variety of thofe Salts from whence they are derived. But why thefe fhould be moftly fupposed of a *Nitrous Nature*, is not fo eafy to prove; for Salt Petre is by no means found in a greater Quantity than the other Salts (efpecially common Salt; (nor is it of a much more Volatile Nature than they, nor capable of being raifed more eafily, or by a leffer heat. But fince Soot, and that which produces it, Smoak, is found to abound very much with a truly Volatile Salt; and fince fuch a kind of Salt is produced frequently by the Putrefaction of Animal and Vegetable Bodies, there is good reafon to fuppose the Air may abound with Salts of this kind: As alfo with many decom-pounded ones, of very different Kinds and Natures, and to which no proper name can well be affigned; and therefore they have been called *Anonymous*, by Mr. Boyle, and many others.

NITRUM, or Nitre, is alfo called Sal-nitri, or Salt-Nitre, from its likenefs to Salt, and Salt-petræ, or Salt Petre, from its fhooting on Walls, which is thus characterifed ⊕ by the Chymifts, and is alfo called by other various and ænigmatical Names, which fhall be fet down with their Interpretations, as they more conveniently offer them-felves in other Places of this Difcourfe, *fed nominet quo quifque vocabulo velit, modo de re conflet inter nos*, faith G. Agricola. It is no matter by what Name it is called, fo we agree about the thing; which is next to be defined.

#### The Peripatetical Definition of Nitre.

Nitre is generally called a Salt, of which it is accounted a Species. G. Agricola calls it a concrete Juice, which he likewife puts for a Genus to Salt, Allum, and Vitriol, which are all diffoluble in Water; and we may without more logical nicety, only adding the word Mineral, admit of either Genus.

And to compleat our Definition, we muft add its Difference; but becaufe we are fo ignorant of the effential Forms of Things, efpecially of Subftances (the right understanding of which, as one expreffeth himfelf, may juftly be faid to transcend the Zenith of the moft raifed Capacity, and to be placed in a *Terra Incognita* to the beft travell'd of human Underftandings) we muft therefore fubftitute its proper Accidents, which flow from their fubftantial Form, and are reciprocal with it, by which it fhall be fufficiently defcribed. The Logician thus imitating the Phyfician in difpenfing the famous Theriacâ, who rather than be without fo excellent a Medicine for want of a few Ingredients, hath his *Succedanea* to fupply their room, and the Antidote rendred no lefs effectual.

Thefe Properties of Nitre are its Figure, Tafte and Inflammability; we fhall refer its firft and fecond Qualities to its Virtues and Ufe.

1. The Figure of Nitre is long like Needles, which may be ocularly demonftrated by diffolving fome Nitre in Water, and boiling it away till it will fhoot, then pour it into a wooden Difh, and fet it in a cool Place, and you will perceive it as it cooleth, to fhoot in Stirias, or long, fmall Figures like Needles, to which Philofophers moft ufually refemble it, and accordingly exprefs themfelves; which, when it hath all fhoot, pour off the Water, and you will fee the Crystallizations condens'd together at the Sides and Bottom of the Difh in large

Figures, but long and very white, the Form of which you may then exactly confider.

2. It hath a falt, fharp and cooling Tafte; it is very hard to exprefs the Tafte, but by the Senfe itfelf; and therefore, as I would have the Figure obferved, according to the former practical Method, fo I would have the Tafte experimented by the Senfe itfelf, by which it will be perceived different from any thing which refembleth it.

3. It is Inflammable, which is experimented by putting a little in the Fire, it immediately takes Flame and burns, leaving little Calx and Afhes behind it; which Fire hath thefe Properties.

1. That it burns with Speed and Vehemency, not fo gradually or mildly as other Subftances.

2. It burneth downwards, contrary to others, which afcend; which may be worth our obferving, by putting about the Quantity of an Ounce in a Fire-fhovel, and a live Coal upon it; when it is all burned, the Firefhovel in the Bottom will be red hot, and burn through whatfoever is under it; if you put it in like Manner on a Board, Brick or Stone, it burns in them a Hole proportionable to the Quantity burnt.

3. We may alfo take Notice of the Clearnefs and Brightnefs of its Flame, difperſing itfelf into Beams like the Sun in its greateft Splendor, and is probably by *Sendivogius* called the central Sun; there doth alfo proceed a great Noife, Smoke and Smell from it, which is very obfervable; and from this burning quality it is faid to be a Water which containeth Fire, by Sir Kenelm Digby. But thefe Properties being demonſtrable, the Mind of a Philoſopher cannot reſt with the Knowledge of the *Quod fit* of them, without the *Quid fit cum Scire*; according to the Philoſopher, *eft per cauſam Scire*, as he would not vainly attempt what is indemonſtrable, fo, what is capable of Logical Demonſtration, he would not neglect; and this being fo difficult to perform, not only in this, but in other Subjects of Natural Philoſophy, it is called but a probable Science; and perhaps I might have paſſed without this Queſtion, had I not propoſed it myſelf. But it is already answered, if I ſay they are demonſtrated by their Form from which they flow, and in the Room of which they ſtand in our Definition, and reciprocal with their Subject; and as it is Peripatetical, fo it is no leſs Philoſophical; for thefe Properties are fo peculiar to their Subject, that they can flow from nothing elſe but their ſpecific Form; and what other reaſons may be given which I have read or thought of, may be too ſubtil to hold; and what validity they have, 'tis only as they are reducible to this; and it may but more betray our Ignorance to mention them; neither doth it leſs become a Philoſopher than the Vulgar, to propoſe the Nature of the Thing for the Cauſe, till we can give a nearer and ſuch a one in which *animus quieſcat*.

3. But it is the Quality of a good Definition, not only to declare itfelf ſo as to be known, but alſo diſtinguiſhed from all other like; as I might particulariſe in this Example, how that theſe Qualities are *propria quarto modo, quæ conveniunt omni, ſoli, & ſemper*, which if they are experimentally known, the moſt exact Botaniſt cannot more certainly know, or nicely diſtinguiſh between the Leaves of wild Campion and Scabious, or Scorzonera and Tragopogon, or other Herbs which ſo much reſemble one another; the experienced Druggiſt ſhall not more accurately diſcover a ſophiſticated Drug from a real, than our Nitrarian may



may distinguish between Nitre and Salt, Allum and Vitriol, which are so like one to another, and may be mistaken by a superficial Observer; but I shall only shew the Differences between Nitre and Salt, that by this Comparison it may be better understood.

Though Salt agreeth with Nitre in the Genus, that it is a mineral Salt, or concrete Juice, yet they differ so in their Properties, that they seem contrary to one another. For, 1. Nitre shoots long in Needles, but Salt shoots in Tesseras or Squares. 2. Salt hath the same Taste with its Name, and is hot and fiery, contrary to Nitre, which is very cooling. 3. It is as contrary also in its burning; Salt (like Gold) being incombustible, but Nitre totally inflammable.

*Of the Generation and Place of Nitre.*

The Generation of natural Bodies is done in secret, which may seem to be not only for the preserving of Heat, being a chief Instrument in natural Productions, but that so sublime and curious a Mystery might not vulgarly be prostituted, but to her most intellectual Observers, who by the Eye of Reason can investigate, what cannot be discovered by the outward Sense. Hence the Manner of the Generation of Minerals, Vegetables, and Animals are as obscure and hid, as the dark subterraneous Mines, the impervious earthly Vegetable, and Female Animal Matrix, being the Places of their Formation, which hath caused those Enquiries the Searchers of Nature have made into these Secrets. They have endeavoured to see the Generation of a Plant, by putting it into the transparent Element of Water. How curiously have many Philosophers watched the hatching of an Egg, that for all the inclosure of the Sperm in the Shell, and covered with the Hen, it should not be kept secret; yet some Chymists pretends to know the Generation of Metals so well, that they can both imitate and perfect Nature in her Mineral Operations. The Works of Art as well as Nature, are kept as obscure in their making. The laborious Bee makes the Fabrick of her Combs in the dark, and within them the Quintessence of her Honey. The Silk-worm works within her Web. The Physicians Experiments are privately dispensed, which, though freely communicated in their Use, yet are more concealed in their Preparations; so that we know the things themselves, but not the Manner of their Productions. No less obscure is Nitre in its Birth, and as difficult to be explained; but we cannot better adhere to any Opinion, than to that of our later Philosophers, *viz.* not that it is a sole Mixture of the Elements, but that Nitre, with other Minerals, in the Beginning of the World, was first created in the Earth; and by the Power given to it from the Creator, hath preserv'd and multiply'd itself. And so from the Creation, not only the Formation of its own Body, but its Propagation and Perpetuation proceeds. Now, that the Form of Minerals is multiplicative of itself in a disposed Matter, and proper Place, is particularly proved in Nitre itself; for, although it be extracted out of nitrous Earth, yet out of the *Mater Nitri vel Petreæ*, the seminary Principle remaining in the Earth, there is more generated and increased, and that not once, but often; as is well known to vulgar Extractors of it.

*The Place of Nitre.*

A Person famous for any Art or Science discoursed of, his Place of Habitation is presently enquired after. The Relation of a Plant of an healing Virtue, is not seldom interrupted with an Enquiry after its place of Growth; and, that Chymist which should be ignorant of the Ground in which Nitre is, and yet his chief Agent in his Operations, would be as culpable, as that Galenist who prescribes such Plants, of whose Form and place of Growth he is too often ignorant. The Artillery Man hath recourse to this place, as to his Magazine, from whence he is furnished with the best of Weapons; therefore, to prevent a Question, as well as to perform what necessarily belongs to this Discourse, we are next to shew the Place in which Nitre is bred, and is resident in.

The Place famous for Nitre among the Antients, was chiefly *Egypt*, where were the *Nitrariæ*, or Nitre Works; but now *East-India*, which glorieth as much in this, as in its Spices, and *Barbary*, are the chief Places; in many Parts of which Countries it is artificially extracted, and transported to us. But it is not there only confined, *Nitrum fert omnis Tellus*; it is an Ubiquitarian, though no place will scarce hold it, being so easily sublimed into the Air, or dissolv'd in Water; yet there is no place without it, though it be not openly in all Countries to be extracted, as in *Asia* or *Africa*, yet it is in our Houses, on Walls, and in the earthen Floors of Halls, Cellars, Butteries, &c. and other out-Houses, as Barns, Stables, Pidgeon-houses, &c. which are capable of breeding and retaining it, where it is often visibly apparent in its proper Figure, and whence it is vulgarly known to be extracted.

**NITRE.** See *Clark's Natural History of Nitre. Lond. 1670. in 8vo.* Mr. Boyle's *Traкт about the Redintegration of Salt Petre.*

**NOBLE**; there hath not been any Piece of Gold (or Silver) of this Name coined with us since 9 H. 5. They were first coined by E. 3. 1744. The Noble contained 80 Pence; its half, which was then called *Obolus* 40 d, its 4th Part the *Quadrans* or *Farthing* in these Days 20 d.

**NOCTAMBULO**, or *Noctambulus*, is one who walks in his Sleep.

**NOCTURNAL**, is an Instrument made of Box, Ivory or Brass, divided on both sides, to take the Altitude or Depression of the Pole-Star, in respect to the Pole itself, in order to find the Latitude and nearly the Hour of the Night.

There are several Sorts of *Nocturnals*, of which some may be Projections of the Sphere; such as the Hemispheres or Planispheres on the Plane of the Equinoctial; but the Seamen use only two, and the Manner of using either is the same. One of them is fitted for the Pole-Star and the first of the Guards of the Little Bear; and the other for the Pole-Star and the *Guards* or *Pointers* (as some call them) of the Great Bear.

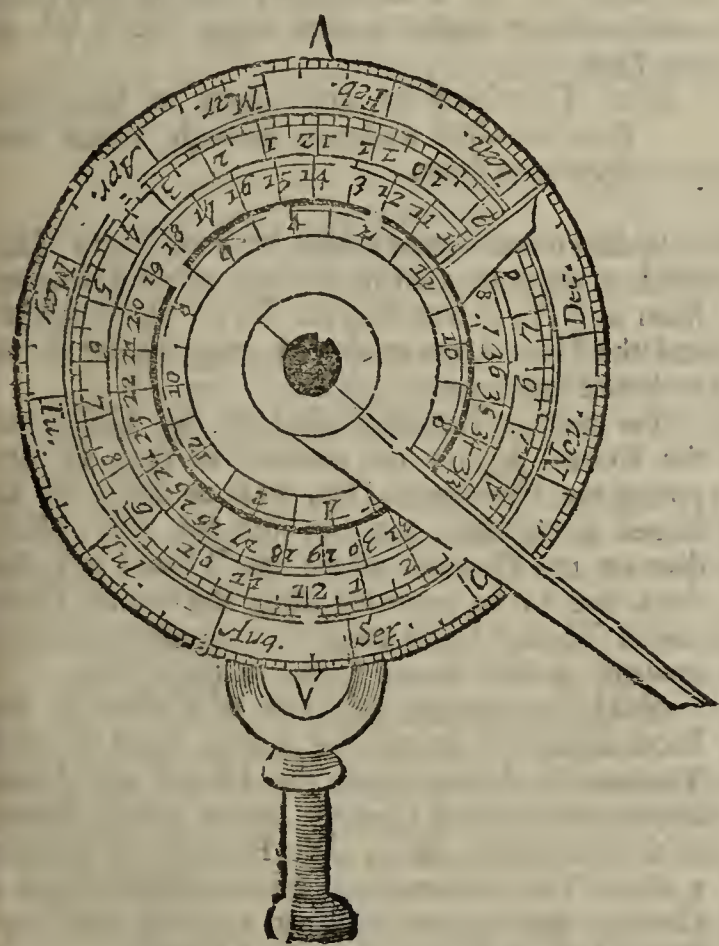
The Instrument consists of three Parts or Pieces; the largest of which hath a Handle to hold it by when you would observe; and opposite to the Handle there is a small Tooth or Point, which (if it be made for the Little Bear) stands against the 25th of *April*; but if for the Great Bear, against the 17th of *February*; which are the Times of the Year



Year when those Stars come to the Meridian at 12 at Night. On this bigger Part or Piece then are two Circles described; the outermost hath the Months and their Days, and the innermost hath the 24 Hours of a Natural Day; on the backside of this Piece also are the 32 Points of the Compass designed, and marked with their initial Letters.

The second Part of the Nocturnal hath two Circles described on it; of which the outermost is divided into  $29\frac{1}{2}$  equal Parts, for the Days of the Moon's Age; and in the innermost into 24 Hours: And at the Beginning of the Days of the Moon's Age, and at XII, there is a Tooth to be set to the Day of the Months in the upper Part.

The third Part is an Index with a Fiducial Edge issuing from the Centre; and must be so long, that a good Part of it may extend beyond the outermost or biggest Piece. These three Parts are so ordered, that by Means of a small hollow Brass Socket they are made to move about the Centre of the Instrument. See the Fig. annexed.



The Uses of this Instrument are;

1. To find the Hour of the Night.

To do which, set the Tooth to the middle Part of the Day of the Month, and then turning the forefide of the Instrument towards you, hold it up towards the North, and incline the upper Part toward you, till thro' the Hole in the Middle you can see the Pole-Star; there hold it fast, and turn the long Index about, till by its Edge you can see either the *first of the Guards of the little Bear*, or the *Pointers of the great Bear*, (according as the Instrument is made) and then shall the Edge of the Index or Ruler, in the innermost Circle of the middle Part shew you the true Hour of the Night.

2. To find on what Point of the Compass the Guards are.

This will appear on the backside of the Nocturnal, after you have found the Hour of the Night,  
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as above; for the Index will be on the same Point of the Compass as the *Guards* really are.

3. To find at what Hour the Moon will be full South on any Day of her Age.

Seek the Moon's Age in the outermost Circle of the middle Piece, and then right against it in the innermost Piece, is the Hour required.

Thus if the Moon be 11 Days old, you will find she will be on the Meridian at 8 Hours 48 min.

NOCTURNAL *Ark*, is that Space in the Heavens which the Sun, Moon or Stars, run thro' from their Rising to their Setting.

*Semi NOCTURNAL Arch of the Sun* [in *Astronomy*] is that Portion of a Circle which the Sun passes over between our Meridian, and the Point of the Horizon wherein it rises; or between the Point of the Horizon where he sets and our Meridian.

NOCTURNAL Pains [with *Physicians*] Pains that frequently are concomitant of Venereal Disorders, which can only be palliated with Narcotics; nor be entirely remov'd by any thing, but a Mercurial Course or a long continued Use of Diet-Drinks.

NOCTURNALABE, is an Instrument used to find how much the *North Star* is higher or lower than the *Pole* at all Hours of the Night.

NOCTILUCA, is one of the two kinds of *Phosphorus*; the former of which, such as the *Bolonian Stone*, *Hermetick Phosphorus Balduini*, &c. will not shine, except first exposed to the Sunbeams, but this kind of *Noctiluca*, is a self-shining Substance, which requires the being exposed to no Light to render it Luminous: As the *Phosphorus* made of Urine, &c. which see in *Phosphorus*.

Mr. Boyle in his Book of the *Aerial Noctiluca*, reckons three of these *Noctiluca*.

1. The *Gummons*, Consistent or Constant one, (as some *Germans* call it) which is in the Form of a Consistent Body.

2. The *Liquid Noctiluca*, which probably is only the former dissolved in a proper Liquor.

3. The *Aerial Noctiluca*, because it would immediately begin to shine, on being exposed to the open Air. See the Process for this last, P. 105. of the afore-mentioned Book, which being much the same with that of the *Phosphorus*, commonly made out of Human Urine, I have omitted. See *Phosphorus*.

NODATED *Hyperbola*: So Sir *Is. Newton* calls a peculiar kind of *Hyperbola*, which by turning round decussates or crosses itself. See *Curves*.

NODE [in *Surgery*] a Tumour arising on the Bones commonly proceeding from some Venereal Cause.

NODES; in *Astronomy*, signify the Points of Intersection of the Orbit of the Sun, or any Planet, with the Ecliptick, so that the Point where a Planet passes over the Ecliptick, out of Southern into Northern Latitude, is called the *North Node*: And where it descends from North to South, 'tis the *South Node*; which *Nodes* (according to some) change their Places in the Zodiack, like the Planets: But Sir *Is. Newton* proves *Prop. 14. Lib. 3.* that the *Nodes* of all the Planets Orbits (as well as their *Aphelia*) are at Rest.

NODULUS, *Nodus*, is a Bag of such suitable Ingredients as the Disease requires, put into Beer or Wine, the Tincture whereof the Patient is to drink.



**NODUS** or *Node*, in *Dialing*, is a certain Point in the Axis or Cock of the *Dial*, by the Shadow of which, either the Hour of the Day in Dials without Furniture, or the *Parallels of the Sun's Declination*, his *Place in the Ecliptick*, the *Italian* or *Babylonish Hours*, &c. are shown, in such Dials as have Furniture.

'Tis an easy thing, and sometimes of good Use, to make Dials which shew the Hour of the Day by an Hole or

**NODUS.** One Method of which, Mr. *Collins* at the End of his Sector on a Quadrant, gives as follows.

First, Draw an Horizontal Dial for the Latitude proposed: Then by the Help of the Sun's Azimuth (which may be found by a Quadrant) or by knowing the Hour of the Day by that Horizontal Dial, draw a true Meridian from the *Hole* or *Nodus* proposed, both above in the Ceiling, and below on the Walls and Floor of the Room; so that if a Right Line were extended from the said *Hole* or *Nodus* to any Point in any of those Lines, it would be in the Meridian Circle of the World.

Next, Fix the End of a Thread in the Centre of the *Hole* or *Nodus*, and move the other End thereof up or down in the said Meridian drawn on the Ceiling or Wall, until by applying the side of a Quadrant to that Thread, it is found to be elevated equal to the Latitude of the Place, then that Thread is directly situated parallel to the Axis of the World, and the Point where the End of that Thread toucheth the Meridian either on the Ceiling or Wall, is that Point in the direct Axis sought for; wherein fix one End of the Thread, which Thread will be of present Use in projecting the Hour-Points in any place proposed.

Then place the Centre of the Horizontal Dial in the Centre of the *Hole* or *Nodus*, and situate it exactly parallel to the Horizon, and its Meridian in the Meridian of the World, (which may easily be done, if at the Instant you know the true Hour of the Day) then take the Thread, whose End is fixed in a Point in the direct Axe, and move it to and fro, until the Thread doth interpose between your Eye, and the Hour Line on the Horizontal Dial, and keeping your Eye in that Position, make a Point or Mark where you please, so that the Thread may interpose between that Point and your Eye; which Point so found, will shew the true Time of the Day at that Hour all the Year long, the Sun shining thereon, so will the Point and the said Thread serve to shew the Hour instead of an Hour-Line.

In like manner, the Thread fixed in the Axis, may be again moved to and fro, until the Thread doth interpose between the Eye and any other Hour-Line desired on the Horizontal Dial, and then (as before) make another Point or Mark in any Place at pleasure, by projecting a Point from the Eye, so that the Thread interpose between that Point to be made, and the Eye, so will that Point so found shew the true Time of the Day for the same Hour that the Hour-Line did on the Horizontal-Dial, which was shadowed by the Thread.

Thus you may proceed (by the help of that Thread and the several Hour-Lines on the Horizontal Dial) to find the other Hour-Points, which must have the same Numbers set to them, as the Hour-Lines on the Horizontal Dial have.

Otherwise, to make a Dial from a Hole in any Pane of Glass in the Window, and to graduate the Hour-Lines on the Ceiling, Floor, &c. that Hole is supposed to be the Centre of the Horizontal Dial, and being truly placed, the Stile thereof, if supposed continued, will run into the Point in the Meridian of the Ceiling before found, where a Thread is to be fixed; then let one extend a Thread fastened in the Centre of the Horizontal Dial, parallel to the Horizon over each respective Hour-Line, and holding it steady, let another extend the Thread fastened in the Meridian in the Ceiling, along by the Edges of the Horizontal Thread, which will find divers Points on the Ground, thro' which, if Hour-Lines be drawn, the Sun shining thro' the Hole in the Pane of Glass, will shew the Time of the Day.

For the Points that will be thus found on the Beam or Transome, the Thread fixed in the Ceiling, or instead of it a piece of Tape there fixed must be moved so up and down, that the Spot of the Sun may shine upon it; and being extended to the Transome or Beam, graduated with the Hour-Lines, it there shews the Time of the Day.

*Note.* That 'twill be convenient to have that Pane of Glass darkned, through which that Spot is to shine.

In like manner may a Dial be made from a Nail-head, a Knot in a String tied any where across, or from any Pin driven into the Bar of the Window, and the Hour-Lines graduated upon the Transome or Board underneath.

To make a Reflected Dial on the Ceiling of the Room, is only the contrary of this, by supposing the Horizontal Dial, with its Stile, to be turned downwards, and run into the true Meridian on the Ground, where the Thread is to be fixed, and to be extended along the former Horizontal Thread (held over the respective Hours) upward, to find divers Points in the Ceiling.

**NOLI me tangere**, is a sort of Canker in the Face, especially above the Chin; there arises a Tumour or Ulcer about the Mouth and Nose, like an exulcerated Canker, which grows slowly at the beginning, like a little Pimple; it remains a whole Year, otherwise is less troublesome than a Canker, which gnaws and eats more in one Day, than a *Noli me tangere*, doth in a Month.

**NOMINATION**; this Word as well by the Canonists as common Lawyers, is used for a Power that a Man hath by virtue of a Manor or otherwise, of appointing or naming a Clerk to a Patron of a Benefice, to be by him presented to the Ordinary.

**NOMBRIL**, or Navel-Point in an Escutcheon: See the Word *Escutcheon*.

**NOMÆ**, are deep and putrid Ulcers in the Mouth. *Blanchard*.

**NOME**, in *Algebra*, is any Quantity with a Sign prefixed to it, and by which 'tis usually connected with some other Quantity, and then the whole is called a *Binomial*, or *Trinomial*, &c. Thus  $a + b$  is called a *Binomial*, whose Names are  $a$  and  $b$ ; and  $a + b + c$  is a *Trinomial*, whose Names are  $a$ ,  $b$ , and  $c$ , &c.

**NON-ABILITY**, in Law is an Exception taken against the Plaintiff or Detendant, upon some Cause why he cannot commence Suit in Law, as *Præmunire*, *Outlawry*, *Profest in Religion*, *Excommunicate*, or a *Stranger born*, which last holds only in Actions real and mix'd, and not in Personal, except he be a Stran-



a Stranger and an Enemy. The *Civilians* say, That such a Man hath not *Personam standi in judicio*.

NON *admittas*. See *Ne admittas*.

NONAGE, a Term in Law, signifying all that Time of a Man's Age, under one and twenty Years in some Cases, and fourteen in others, as Marriage.

NONAGESIMAL Degree, is the highest Point, or 90th Degree of the Meridian.

NONAGIUM [in Law] the ninth part of moveable Goods which was antiently paid in the nature of a Mortuary being claim'd by the Clergy upon the Death of their Parishioners.

NON Appearance [in Law] a Default in not appearing in a Court of Judicature.

NON-CLAIM, a Term in Law, signifying the Omission or Neglect of him that ought to challenge his Right within a time limited, by which Neglect he is either barr'd of his Right, as at this Day upon *Non-claim* within five Years after a Fine, and Right to him accrued; or of his Entry by his Descent, for want of *Claim*, within five Years after the *Disseisin*.

NON *compos mentis*; That is, not of sound Memory or Understanding; of such in Common Law they reckon:

First, An Ideot born.

Secondly, He that by Accident wholly loseth his Memory and Understanding.

Thirdly, A Lunatick, that hath *Lucida intervalla*; sometimes has Understanding, and sometimes not.

4. He that by his own Act for a Time depriveth himself of his right Senses, as a Drunkard; but this last kind shall give no Privilege to him or his Heirs.

NON *distringendo*, is a Writ comprising under it divers Particulars, according to divers Cases, See Tab. of Orig. Reg. Verb. *non distringendo*.

NONES of a Month, are the next Days after the Kalends, which is the first Day. In *March*, *May*, *June* and *October*, the *Romans* accounted six Days of the *Nones*, but in all the rest of the Months but four. They had this Name probably because they were always 9 Days inclusively, from the first of the *Nones* to the *Ides*; i. e. reckoning inclusively both those Days.

NON *est Culpabilis*, in Law, signifies the general Plea to an Action of Trespass, whereby the Defendant doth absolutely deny the Fact imputed to him by the Plaintiff; whereas in other Special Cases the Defendant but alledgeth some reason in his own Defence.

NON *est factum*, is an Answer to a Declaration, whereby a Man denieth that to be his Deed, whereupon he is Impleaded.

NON *Implacitando aliquem de libero tenemento sine brevi*, is a Writ to inhibit Bayliffs, &c. from distraining any Man without the King's Writ, touching his Free-hold.

NON *Intromittendo, quando breve de Præcipe in Capite subdole impetratur*, is a Writ directed to the Justices of the Bench, or in *Eyre*, willing them not to give one that hath, under colour of Intitling the King to Land, &c. as holding of him in *Capite*, deceitfully obtained the Writ called *Præcipe in Capite*, but to put him to his Writ of Right, if he think good to use it.

NON *Merchandizanda Victualia*, is a Writ directed to the Justices of Assize, commanding them to enquire, Whether the Officers of such Towns

do sell Victuals in Gross, or by Retail, during their Office, contrary to the Statute, and to punish them if they find it true.

NON *Molestando*, is a Writ that lieth for him which is *Molested*, contrary to the King's Protection granted him.

NON-Natural Things, or the Non-Natural Causes of Diseases, as the Physicians reckon them are six, viz. The Air, Meat and Drink, Sleep and want of Sleep, the Motions and Repose of the Body, the Retention, or Evacuation of the Excrements and Recrements of it, and the Passions of the Mind.

NON-Organical Part of an Animal, is that whereto some Use is only appropriated, but no Action, as a Gristle, Bone, Foot, &c.

NON *Obstante*, is a Clause frequent in Statutes and Letters Patent; it signifies *Notwithstanding*, and was first brought in by the Pope, and in the Reign of Hen. 3. was used by that King in his Grants, &c.

NON *omitt. propt. aliquam libertat.* is a Writ that lies where the Sheriff returns upon a Writ to him directed, that he hath sent to the Bayliff of such a Franchise which hath the return of Writs, and he hath not served the Writ, then the Plaintiff shall have this Writ directed to the Sheriff to enter into the Franchise, and execute the King's Process himself. Also the Sheriff shall warn the Bayliff, That he be before the Justices at the Day mentioned in the Writ, and if he come not, then all the Judicial Writs, during the same Plea, issuing, shall be Writs of *Non Omittas*, and the Sheriff shall execute the same.

NON Plevin [in Law] a default in not replevying Land in due time.

NON *Ponendis in Assisis & Juratis*, is a Writ founded upon the Statute of West. 2 cap. 38. and *Articuli super Chartas*, cap. 9. which is granted upon divers Causes to Men, for the freeing them from Assizes and Jurors.

NON *Procedendo ad Assisam Rege inconsulto*, is a Writ to stop the Trial of a Cause appertaining unto one that is in the King's Service, &c. until the King's Pleasure be further known.

NON *Residentia pro Clericis Regis*, is a Writ directed to the Ordinary, charging him not to molest a Clerk employ'd in the King's Service, by reason of his *Non-Residence*.

NON-Residence, in Law, is applied to such Spiritual Persons as are not Resident on, but do absent themselves for the space of a Month or two, at several times in one Year from their Benefices; for *Personal Residence* is required of Ecclesiastical Persons upon their Cures.

NON *Sane Memory*, in Law, is an Exception taken to an Act declared by the Plaintiff or Demandant, to be done by another, whereupon he grounds his Complaint or Demands: And the Effect of it is, That the Party that did that Act was mad, or not well in his Wits when he did it, See *Non compos mentis*.

NON *Solvendo Pecuniam ad quam Clericus mulctatur pro non Residentia*, is a Writ prohibiting an Ordinary to take a Pecuniary Mulct imposed upon a Clerk of the King, for *Non-Residence*.

NON-Suit, in Law, is Renouncing of the Suit by the Plaintiff or Demandant, most commonly upon the Discovery of some Error or Defect, when the Matter is so far proceeded in, as that the Jury is ready at the Bar to deliver their Verdict. The *Civilians* term it, *Litis renunciationem*. And in what



what Cases a Man cannot be *Non-Suit*. See the Statute of 2 H. 4. cap. 7.

*NON Sum Informatus*. See *Informatus non Sum*.

*NON Tenure*, in Law, is an Exception to a Count, by saying, That he holdeth not the Land specified in the Count, or at least some part of it: And 'tis either *Non Tenure General*, or *Non Tenure Special*: The *Special Tenure*, is an Exception, alledging that he was not Tenant the Day when the Writ was purchased. *Non Tenure General*, is when one denies himself ever to have been Tenant to the Land in Question.

*NON TERM* [in Law] the time of Vacation between Term and Term.

*NORMAL*, the same with Perpendicular, or at Right Angles, and 'tis usually spoken of a Line or a Plane that intersects another Perpendicularly.

*NORTH*, in Cosmography, one of the Cardinal Points of the Horizon, being that Intersection of the Horizon and Meridian nearest the North Pole.

*NORTH-Star*, the last in the Tail of the little Bear; called also the Pole-Star.

*NORTH-East*, a Rhumb, or Point, in the middle between the East and the North.

*NORTH-West*, is a Point or Rhumb in the middle between the North and West.

*NORTH North-East* and by East; are subdivisions of the Compass between the North and East.

*NORROY*, or *North-Roy*, i. e. the Northern King, is the Title of the Third of the three Kings at Arms in the Heralds-Office. His Province lies on the North-side of *Trent*.

*NORTHERN Signs of the Ecliptick or Zodiack*, are those Six which constitute that Semi-circle of the Ecliptick which inclines to the Northward from the Equator, as *Aries*, *Taurus*, *Gemini*, *Cancer*, *Leo*, *Virgo*.

*NOSOCOMIUM*, is an Hospital for Poor Sick People, where they are attended, and cured, if possible.

*NOSOLOGY* [*Νοσολογία* of νόσος a Disease, and λόγος, Gr. a Word] a Discourse or Treatise of Diseases.

*NOSTRILS* [in *Anatomy*] the two Apertures or Cavities of the Nose through which the Air passes, serving to convey Odours and to carry off the *Pituita*, separated in the *Sinus* of the Basis of the *Cranium* or Skull. They are separated by a Cartilage and lined with a very sensible Membrane.

*NOTATION*, in Arithmetic, the Art of Characterizing Numbers, or of designing them by proper Figures.

The Choice of Arithmetical Characters is Arbitrary. Hence, in various Nations, they are various; but perhaps there are none so commodious as those commonly used in *Europe*, usually said to have been invented by the *Arabs*, and thence called *Arabic Characters*; though Dr. *Wallis* observes, that *Altepedi*, an *Arab*, refers the Invention to the *Indians*.

The *Greeks*, *Hebrews* and other Eastern Nations, as also the *Romans*, express'd Numbers by the Letters of their common Alphabet.

*NOTATION*, in Algebra, is the representing of Quantities by Letters of the Alphabet; or calling them by those Names.

*NOTARY*, is mentioned in 27 E. 3. and is a Scribe or Scrivener, which makes short Draughts of Writings or Instruments. At this Day we call

him a *Notary* or *Notary Publick*, that attests Deeds or Writings to make them authentick in another Country; and chiefly in Business relating to Merchants.

*NOTES* in Musick, are certain Terms invented to distinguish the Degrees of Sound in Tuning, and the Proportion of Time thereto belonging: For in regard that a Voice doth express a Sound best, when it pronounceth some Syllable or Word with it, six select Syllables were formerly used to that Purpose, ascending and descending in order, viz. *Ut*, *Re*, *Mi*, *Fa*, *Sol*, *La*; but four of them, viz. *Mi*, *Fa*, *Sol*, *La*, being found sufficient for the right Tuning of all the Degrees or Sound, and less burthenome to the Memory, the other two, *Ut* and *Re*, are generally now laid aside as superfluous. It is reported, That *Guido Aretinus*, having undertaken to reduce the *Greek Scale* of Musick to a more regular Form about A. D. 960, assumed for the Names of these six Notes as many Syllables taken out of the *Sapphick Hymn* of St. *John Baptist*, which began thus:

Ut queant Laxis Resonare fibris.  
Mira Gestorum Famuli tuorum,  
Solve polluti Labii reatum.

As for other sort of Notes relating to Time, they are Nine in Number, viz. *Large*, *Long*, *Breve*, *Semi-breve*, *Minim*, *Crotchet*, *Quaver*, *Semi-quaver*, and *Demi-semi-quaver*. The four first are usually termed *Notes of Augmentation*, or *Increase*, and the five last of *Diminution* or *Decrease*. The *Semi-breve* being the last of Augmentation, is commonly called the *Master-Note*, or *Measure-Note*, or *Time-Note*, because it is of a certain determinate Measure or Length of Time by itself; and all the other Notes both of *Augmentation* and *Diminution*, are measured by, or adjusted to its value. But it ought to be observed, that the *Large* and *Long* are now of little use, as being too long for any Voice or Instrument (the Organ only excepted) to hold out to their full length; altho' their *Rests* are still very often used, more especially in Grave Musick, and Songs of many Parts.

*NOTHÆ costæ*, are the five lowest Ribs on each side, called *Bastard Ribs*; so named, because they do not join with the Breast-bone as the other Ribs do, nor are they as the others, Boney, but Cartilaginous.

Diseases are likewise called *Nothi*, or *Bastard*, when they agree not with the Ordinary and Common Rules, as *Tertian*, *Quartan*, and *Quotidian*, *Bastard Agues*, *Bastard Pleurifies*. &c.

*NOTIONAL Quantity*. See *Quantity*.

*NOVACULA*, is a Chirurgeon's Knife, the Shape whereof differs according to the Difference of Operations.

*NOVATION*, in the *Civil Law*, is a transferring the first Obligation given by a Debtor to a Creditor, into another.

*NOVEL Assignment*, in Law, is an Assignment of Time, Place, or the like, otherwise than as it was before assigned. See *Assignment*.

*NOVEL Disseisin*. See *Assize of Novel Disseisin*.

*NOUNS* (in *Grammar*) are such Words as signify the several Objects of our Thoughts.

*NOWED* [in *Heraldry*,] i. e. knotted, a Term applied to the Tails of Creatures that are very long, and sometimes represented in Coat Armour as tied up in a Knot.

NU-



NUBECULÆ are little light Particles which mutually, but loosely close one with another, and swim upon the Urine.

NUCAMENTUM in *Phytology*, or *Botanicks*, is the same with *Fulus*. Which see.

NUCHA is the hinder part, or Nape of the Neck, called also *Cervix*.

NUCIOSITAS: the same that *Myopia*.

NUCIFEROUS Plants or Shrubs are such as bear Nuts.

NUCKIANÆ *Glandulæ*, are a sort of Glands (first taken notice of by Dr. Nuck) seated in that Orbit of the Skull, wherein the Eye is placed betwixt the abducent Muscle of the Eye, and the upper part of the *Os jugale*. Their Shape is various, in some Oblong, in others flattish Round, in others Oval, and in others somewhat Triangular.

NUCLEUS is the Edible part of the Kernel of any Nut, which is contained within the Skin of the Kernel; and in a larger Sense is by Botanists used for any Fruit or Seed contained within an Husk or Shell.

NUCLEUS also in an Astronomical Sense is by *Hewelius* and others used for the Head of a Comet, and by others for the Central Parts of any Planets.

NUCLEUS, in Architecture, is the middle part of the Flooring of the Ancients, consisting of Cement, which they put betwixt a Lay or Bed of Pebbles cemented with Mortar made of Lime and Sand.

NUDE Contract, in Law, is a bare Promise of a thing, without any consideration; and therefore 'tis said, *Ex nudo pacto non oritur actio*.

NUDE Matter, in Common Law, is a naked Allegation of a thing done, to be proved only by Witnesses, and not either by Record or other Speciality in Writing under Seal.

NUDITIES [in *Painting*, &c.] are those parts of a human Figure, that are not covered with any Drapery; or they are those parts where the Carnations appear.

NUEL of a Stair-case. See NEWEL.

NUMBER is Discrete Quantity, or a Collection of Unites, and is that which teacheth us to know how many any of the Objects of our Knowledge are.

Every Number in *Arithmetick* (which is the Art of Numbering truly) may be considered as composed of two Parts, of which one may be called the *Denominator*, and the other the *Numerator*.

Thus the Number 9, as it signifies the Thing Numbered, as the 9 Muses, or 9 Men, 9 Pounds, &c. is a *Denominator*: But as it expresses how many of that thing are taken or accounted, it is a *Numerator*. Therefore when the *Denominator* signifies a whole thing, the Number is called an *Integer*; but if it signifies or stand for the Parts of any thing, then the Number is a *Fraction*.

Thus Nine Shillings, considered as distinct Things, are an *Integral Number*; but when you consider them as  $\frac{9}{20}$  Parts of a Pound Sterling, that Number is a *Fraction*: And the Knowledge of this will facilitate the Understanding of the *Doctrine of Fractions*, which appears difficult to Beginners, because they do not consider that as well *Integer Numbers* as *Fractions* have both *Numerators* and *Denominators*: The Difference lying chiefly here, That in *Integers* the *Ratio* of the *Denominators* is certain, one and the same; but in *Fractions* 'tis innumerable: For the *Ratio* of

the *Denominators* in *Fractions* is as various as the Nature of the Parts into which any Whole may be divided, which in *Vulgar Fractions* is Infinite. *Wells's Arithmetick*.

A *Determinate* NUMBER is a Number which is referred to some given Unite, as a ternary or three; this is what is properly called Number.

An *Indeterminate* NUMBER is such as is referred to Unity in the general; and is that which is called Quantity.

*Homogeneous* NUMBERS are such as are referred to the same Unite.

*Heterogeneous* NUMBERS are such as are referred to different ones.

*Rational* NUMBER is one which is commensurable with Unity.

*Rational whole* NUMBER is one whereof Unity is an *aliquot* part.

*Rational broken* NUMBER is one that is equal to some *aliquot* parts.

*Rational Mixt* NUMBER is such as consists of a whole number of Unity, and a broken one, or of an Unity or a Fraction.

*Irrational* NUMBER a Number, that is incommensurable with Unity. A Surd.

An *even* NUMBER is such an one as may be divided into two equal Parts, or without any Remainder or Fraction, as 4, 8, 12, &c. An even Number is said to be evenly even, when it may be measured or divided by another *even Number* without leaving any remainder.

An *uneven* NUMBER is such as exceeds an *even Number* at least by Unity, or which cannot be divided into two equal Parts as 9, 19, 27.

*Primitive* NUMBER, } [in *Arithmetick*] is  
*Prime* NUMBER, } such an one that is divisible only by Unity, as 5, 7, 11, 15, &c.

*Prime* NUMBERS among themselves are such Numbers as have no common Measure besides Unity, as 12 and 19.

*Compound* NUMBER is one which is divisible by some other Number besides Unity, as 8, which is divisible by 4 and by 2.

*Compound* NUMBERS among themselves, are such as have some common Measure besides Unity as 12 and 15.

*Perfect* NUMBER is such an one, the *aliquot* parts of which being added together make the whole Number, as 6, 28, &c. the *aliquot* Parts of 6 being 3, 2 and 1, which are equal to 6, and those of 28 being 14, 7, 4, 2, 1, which together are equal to 28.

*Imperfect* NUMBER is such, the *aliquot* parts of which being added together, make either more or less than the whole, of which they are Parts, as

*Abundant imperfect* NUMBERS are such, the *aliquot* parts of which make more than the Number of which they are parts, as 12, the *aliquot* parts of which are 6, 4, 3, 2, 1, which together make 16.

*Defective imperfect* NUMBERS are such, the *aliquot* parts of which being added together make less than the Number of which they are parts, as 16, the *aliquot* parts of which are 8, 4, 2 and 1, which all added together make but 15.

*Plane* NUMBER [in *Arithmetick*] is one that arises from the Multiplication of 2 Numbers only, as 8, which is the Product of 4 multiplied by 2.

*Square* NUMBER is the Product of any Number multiplied by itself, thus 9 is a square Number of 3 multiplied by 3.



*Cubick* NUMBER is the Product that arises by a square Number multiplied by its Roots; thus 27, is a Cubick Number of 9 the Square of 3 multiplied by the Root 3.

All Cubick Numbers whose Root is less than 6, v. 9, 8, 27, 64, 125 being divided by 6 the Remainder is their Root itself; thus 8 being divided by 6, 2 the Remainder of the Division is the Cube Root of 8. For the *Cubick Numbers* beyond 125; 216 the Cube of 6 divided by 6 leaves no Remainder; 346 the Cube of 7 leaves a Remainder 1, which added to 6 gives the Cube Root of 343. And 512 the Cube of 8 divided by 6 leaves 2, which added to 6 makes the Cube Root of 512.

So that the Remainders of the Divisions of the Cubes above 216 divided by 6 being added to 6, always give the Root of the Cubick Number divided; till that Remainder be 5, and of consequence 11 the Cube Root of the Number divided: but the Cubick Number above this being divided by 6 there remains nothing, the Cube Root being 12.

Thus if you continue to divide the higher Cubes by 6, you must not add the Remainder of the Division to 6, but to 12, and thus coming to the Cube of 18, the Remainder of the Division must not be added to 12 but to 18, and thus in *infinitum*.

*Monf. de la Hire*, from considering this Property of the Number 6 with regard to *Cubick Numbers*, found that all other Numbers raised to any Power whatsoever, had each their divisor, which had the same effect with regard to them that 6 has with regard to the Cube, and the general Rule; he has discover'd is this. If the Exponent of the Power of a Number be even, *i. e.* if that Power be rais'd to the 2, 4, 6th, &c. Power, it must be divided by 2, and the Remainder if there be any added to 2, or to a multiple of 2, gives the Root of the Number corresponding to its Power, *i. e.* to the 2d or 6th Root, &c.

But if the Exponent of the Number of the Power be uneven, *i. e.* if it be rais'd to the 3d, 5th, 7th, Power, &c. the Duple of that Exponent will be the Divisor which shall have the Property here required.

*Golden* NUMBER in Chronology, is a Period of 19 Years invented by *Meton* the *Athenian*; at the end whereof the same Lunations return in the same Days, though not precisely in the same Hour and Minute of the Day.

Hence this Period, call'd by the *Greeks* *Enneadecaeteris* is not perfectly just, there being a Proemptosis or Leap at the End of 312 Years, *i. e.* in that time the Lunations fall out a Day sooner than the *Golden* Number expresses them.

This among other things was what engag'd *Pope Gregory XIII.* to reform the Calendar, to throw out the *Golden* Number and substitute the Cycle of Epacts instead of it. For the Use of the *Golden* Number, which in the *Julian* Calendar serves to find the New Moons, only serves in the *Gregorian* to find the Cycle of Epacts.

This Number is said to have had its Name *Golden* from the greatness of its Use; or because the *Athenians* received it with so much applause, that they had it written in the publick Markets in Letters of Gold. *M. Cassini* defines the *Golden* Number after a new Manner. He says, 'tis the number of Years elaps'd, since that which had the New Moon on its first Day: As that of the Year

1500, whose *Golden* Number was nothing, which he takes for his Epocha.

NUMBERS in Poetry, Oratory, Musick, &c. are certain Measures, Proportions or Cadences, which render an Air, Verse or Period agreeable to the Ear.

*Poetical* and *Prosaic* NUMBERS are something different. *Poetical* Numbers consist in a certain Harmony in the Order, Quantities, &c. of the Feet and Syllables; which make the Piece musical to the Ear, and fit it for Singing, for which all the Verses of the Antients were intended. The Numbers are what constitute the Air and Character of a Verse, and denominate it *smooth* or *soft*, or *low* or *rough*, or *rapid* or *sonorous*.

*Rhetorical* or *Prosaic* NUMBERS are a sort of simple unaffected Harmony, less glaring than that of Verse, yet such as is perceived and affects the Mind with Pleasure. The Numbers are that by which the Style is said to be *easy*, *free*, *round*, *flowing*, &c.

Numbers are a thing absolutely necessary in all Writing, and even all Speech. Hence *Aristotle*, *Tully*, *Quintilian*, &c. lay down abundance of Rules as to the intermixing *Dactyls*, *Spondees*, *Anapests*, *Jambus's*, *Choraic* and *Dichoraic* *Molossus's*, &c. in order to have the Numbers perfect.

The Substance of what they have done is reducible to what follows. 1. The Style becomes numerous by the alternate Disposition and temperature of long and short Syllables; so as that the Multitude of short ones neither renders it too hasty, nor that of long ones too flow and languid. Sometimes indeed long and short Syllables are thrown together designedly without any such Mixture to paint the Celerity or Slowness of a thing by that of the Numbers.

2. The Style becomes numerous by intermixing the Words of one, two or more Syllables; whereas the too frequent Repetition of Monosyllables renders the Style pitiful and grating.

3. It contributes greatly to the Numerousness of a Period to have it clos'd by Magnificent and well sounding Words.

4. The Numbers depend not only on the Nobleness of the Words in the Close, but of those in the whole Tenor of the Period.

5. To have the Period flow easily and equably, the harsh Concurrence of Letters and Words is to be studiously avoided, particularly the frequent meeting of rough Consonants. The beginning the first Syllable of a Word with the last of the Preceeding. The frequent Repetition of the same Letter or Syllable. And the frequent Use of the like ending Words.

Lastly, The utmost care is to be taken, lest in aiming at Oratorical Numbers you fall into *Poetical* ones, and instead of Prose write Verse.

NUMERAL Letters, those Letters of the Alphabet which are generally used for Figures, as I. V. X. C. D.

NUMERALS in Grammar, are those words which express Numbers, as six, eight, ten, &c.

*Polygonous* NUMBERS are the Sums of Arithmetical Progressions beginning with Unity.

*Pyramidal* NUMBERS are the Sums of *Polygonous Numbers*, collected after the same manner as the Polygons themselves are, which are gathered out of Arithmetical Progressions.

NUMBRING Rods, the same with *Neper's Bones*.



9 8 7 6 5 4  
46879035678946325012389765432017896  
3 2 1  
734532123456789876543210

NUMMATA *Terræ*, a Term formerly used in some old Grants, and thought to be the same with

NUTRITION: The Course or Process of the *Aliment* in order to the Nourishment and Support of an Human Body, is thus performed. The Meat we eat being grossly divided and ground by the Teeth, is in that Action mingled with the *Saliva*, which helps to ferment and dilute it. Thence thro' the *Oesophagus* or Gullet by the Constriction of its Fibres 'tis thrust down into the Stomach; where being further softened and swell'd by the Juices contained in the Glands of the Stomach, its Parts are farther broken and the intimate Cohesion of them destroyed, and they divided one from another, by the perpetual Motion of the Coats of the Stomach and by the Muscles of the *Midriff* and *Abdomen*. By this Pressure also of the Sides of the Stomach upon the contained Aliment, that is thrust down into the Intestines; at its Entry into which it is mix'd with the Bile and Pancreatick Juice, the one to sweeten, the other to dilute the Chyle. By the *Peristaltick Vermicular* Motion of the Guts, (arising from the Alternate Action of their



their Spiral and Longitudinal Fibres) and by the Pressure of the *Diaphragm*, and the Muscles of the *Abdomen*, the grosser Parts of the Chyle are derived downwards to be thrust out of the Body; while the finer are squeezed into the narrow Orifices of the *Lacteal Veins*, which open into the Intestines; from whence in slender Channels they are carried into the Glands of the Mesentery; where they receive a fine thin *Lympha* from the *Lymphatick Ducts*, which further dilates it and scours its containing Vessels; which Vessels going from those Mesenterick Glands unite into larger Channels, and those into still larger, and at last pass directly into the common Receptacle of the Chyle; which is a kind of Basin formed for it in the Union of these *Lacteal* and *Lymphatick* Vessels. From thence in one Duct it ascends into the *Thorax*, and sometimes dividing about the Heart, it immediately unites again, and creeping along the Gullet, it passes on to the left *Subclavian Vein*, where in one or two Months it pours in its Contents, and there mixes with the poor Venal Blood returning from all Parts of the Body. And thus doth the Blood receive its Supply and Nourishment.

But if you take *Nutrition* in the Sense which some do, of the Blood nourishing the several Parts of the Body: Then will that kind of Nutrition be performed by a *Secretory Duct* arising from the Termination of an Artery, and carrying a suitable Portion of the Blood to every Part to be nourished; so that every Point of the Body must be the Termination of a *Secretory Duct*, thro' which a proper Part of the Blood is brought in order to supply that Part of the Body.

**NUTRITUM** a desiccative cooling Ointment prepared by the Agitation and Nutrition of some Preparation of Lead with Oil and Vinegar, or the Juice of *Solanum* in a Mortar.

**NUX**, is a sort of Pain in the Head, which afflicts a Place as big as a Nut; as an *Ovum* or *Clavus* is another sort, where the Seat of the Pain is larger.

**NYCHTHEMERON**, [*νυκθημερον* of *νύξ* Night and *ἡμέρα*, Gr. Day.] is Four and twenty Hours Space, or an entire Day and Night.

**NYCTALOPIA**, [*νυκταλοπία* of *νύξ* and *ἀλὰς* and *ὥψ*, Gr.] is Two-fold, The First is a Dimness of the Sight in the Night, or in dark Places, without any Impediment in the Light. The other is Dimness in the Light, and clear Sight in the Night, or in shady Places.

Or it is a Disease in the Eyes which prevents their seeing when the Sun is set and the Light begins to diminish. Others will have the *Nyctalopia* to be properly a Disease that prevents the seeing by Day, but not by Night; which is the Sense *Hippocrates* uses it in, and in which sense it is supposed to be owing to the Spirits, being too much dissipated in the Day but collected by Night.

However in the general, any Disease which prevents the seeing at any particular time when others see, is called *Nyctalopia*.

*Boerhaave* says, the *Nyctalopia* consists in this, that the *Uvea* is immoveable, and at the same time very open.

In the *Philosophical Transactions* we have an Instance of a *Nyctalopia*, or *Nocturna Cecitas*, in a young Man of 20 Years of Age, who had been affected with it as long as he could remember. Dr. *Parham* assures us, he had a good Sight all Day and distinguish'd Objects at all Distances as well as any body; but when Twilight once came he was quite Blind and saw nothing at all, nor could make scarce any use of either Fire, Candle or Glasses; yet his Eyes upon Examination shew'd nothing at all amiss, nor had he any Vertigo or other Disease of the Head; the Cloudiness as he himself told the Doctor, used to come gradually on him like a Mist as Day-light declined. He always saw alike in all Aspects of the Moon, felt no Pain by Fire or Candle-light, and was the same in Summer as Winter. Dr. *Briggs* accounts for the Case thus: "As Vapours are raised in great Quantity during the day time; which being condensed by the Coldness of the Evening fall again and render the Air near the Earth the thicker; so perhaps the Humours in the Eyes of this Youth may be affected, and in the Evening rendered grosser and more turbid, as Heat or Cold is applied to them. By such thickness or spissitude of the Humours, the Rays being either reflected or too much refracted, do not reach the *Retina*, or at least strike it too feebly".

**NYMPHÆ**, [*νυμφαί*] are little soft Pieces of Flesh, arising from the Commissure of the *Os pubis* within the *Vagina*; so called, because they stand near the Passage of the Water that comes out of the Bladder.

Also the Hollowness or void Space in the Nether Lip is so called.

**NYMPHA**, [*νυμφή*, Gr.] in such Insects as undergo a Transformation, is the very first Change of the *Eruca*, or of the *Vermiculus Prior*, or *Maggot*; or indeed, as *Swammerdam* hath proved (in his *Hist. Insect. general.*) rather the Growth and Increase of the *Eruca*, whereby the Figures of the succeeding Animal is beginning to be expressed by the Explication of its Members, which before lay involved up in the *Eruca* (like a Plant in its Seed;) so that in Reality it is only the Animal under that imperfect Form is called the *Nympha*, the Word being taken from *Aristotle* in his *Hist. Anim. Lib. v. c. 19.* where he uses it for the first Rudiment of an Insect. This *Nympha* is sometimes called *Chrysalis*, sometimes *Aurelia*, and sometimes *Necydalus*; all which Terms signify the same Thing.

**NYMPHOMANIA**, [*νυμφή* and *μανία*, Gr. Madness] the same with *Furor Uterinus*.

**NYMPHOTOMY**, [*νυμφωτομία* of *νυμφή* and *τομή* a Cutting, Gr.] is a Cutting off the *Nymphæ*, the too great Protuberance whereof in Marriageable Virgins sometimes hinders the *Coitus*, or at least renders it difficult. The *Egyptians* cut them frequently, as *Galen* saith; but in our Parts of the World such Instances have been very rare.



## O.

**O.** The Seven *Antiphones* or Alternate Hymns of Seven Verses, &c. sung by the Choire in the Time of *Advent*, was formerly called *O*, from their Beginning with such an Exclamation.

**OAKHAM**, (a Term used in the Yards for building Ships) is old Ropes untwisted and pulled again out fine, into loose Hemp or Flax, with a Design to drive it into the Seams, Trennels, and Rends of a Ship, to stop or prevent a Leak.

**OAR**, in Navigation, an Instrument whereby a Boat, Barge, Galley, &c. is rowed or advanced along the Water.

In a Vessel with Oars, the Water is to be considered as the Point of Support, or Fulcrum; the Oar as a Lever, the Boat as the Burden to be moved, and the Rower's Hand the moving Power.

The Burden is to be considered to that Point of the Lever, where the Oar rests on the Boat; the greater therefore the Distance of the Hand from that Point, and the less Distance the Water from that Point, the greater Effect will the Oar have.

**OATH**, in the Law-Sense, is an Affirmation or Denial by any Christian of a Thing lawful and honest, before one or more that have Authority to give the same; for the Advancement of Truth and Right, calling Almighty God to witness that his Testimony is true. 'Tis called sometime *his Corporal Oath*, because he toucheth with his Hand some Part of the Holy Scripture of the *New Testament*, and most usually of the Four Gospels (whence the Phrase for lawful swearing is *Sacrosanctis Testis Evangelii*.)

**OAZY**, or *Oazie Ground*: So the Seamen call soft, slimy, muddy Ground. This is not good Anchorage, because the Anchor cannot hold firm, but will *come home* (as they call it) in a Stress of Weather; besides it will rot their Cables, if a Ship ride long over such Ground: But then it is good to bring a Ship a-ground upon, because she can there dock herself, and lie soft; but yet if she lie long, she will rot her Plank, and spoil the Oakham in her Seams.

**OBEDIENTIA**, was anciently used as a Term for Rent; but in the Common Law 'tis taken for an Office, or for the Administration of an Office; and thereupon

**OBEDIENTIALES**, is used in the Provincial Constitutions for those that have the Execution of any Office under their Superiors.

**OBELÆ**, is the *Sagittalis Sutura* in the Skull, (see *Sagittalis*) which touches the *Coronal Suture* forward, and the *Lamdoideal* backward; for it is made of the mutual Conjunction of the Bones of the Forehead. *Blanchard*.

**OBELISK**, [in *Grammar*] a Character in the Form of a Dagger (†) serving to refer the Reader to some Note, or other Matter in the Margin.

**OBELISK**, is a magnificent high Piece of solid Marble, or other fine Stone; having usually four Faces, and lessening upwards by Degrees, till it ends in a Point like a Pyramid.

**OBJECTIVE-Line**. See *Line Objective*.

**OBJECT-Glass**, of a Telescope or Microscope,

is that Glass, which is placed at that End of the Tube which is next the Object.

*To prove the Regularity and Goodness of an Object-Glass.*

Strike two concentric Lines on a Paper, the one having its Diameter the same with the Breadth of the Object-Glass; the other half that Diameter; divide the inner Circumference into six equal Parts, and making six fine Holes therein with a Needle; cover one Side of the Glass with this Paper, then exposing it to the Sun, receive the Rays that pass thro' these six Holes, on a Plane, at a just Distance from the Glass; and by with-drawing or approaching this Plane, from or to the Glass, we shall find whether the Rays that pass thro' these six Holes unite exactly together at any Distance from the Glass; if they do, we may be assured of the Regularity of the Glass; that is, of its just Form, and at the same time we may obtain exactly the Glass's Focal Length.

Indeed there is scarce any better way of proving the Excellency of an Object-Glass, than by placing it in a Tube, and trying it with small Eye-Glasses at several distant Objects; for that Object-Glass that represents objects the brightest, and most distinct, that bears the greatest Aperture, and most Convex, and Concave Eye-Glasses, without Colouring or Haziness, is the best.

*To prove whether Object-Glasses be well center'd.*

Hold the Glass at a due Distance from the Eye; and observe the two reflected Images of a Candle; where those Images unite or coalesce, there is the true Centre, if this be in the middle, or Central Point of the Glass, 'tis truly centred.

**OBIT**, signifies an Office for the Dead or a Funeral Solemnity: The Anniversary of any Person's Death was also called an *Obit*. And in Religious Houses, &c. they had formerly an

**OBITUARY**, which was a Register or Calendar wherein they enter'd the Obits or Obital Days of their Founders or Benefactors.

**OBLATA**; were formerly Gifts made (tho' properly Offerings) to the King by any of his Subjects; and were so carefully taken Notice of by King *John* and *Hen. 3.* that they were enter'd in the fine Rolls under this Name of *Oblata*.

**OBLATA**, is a Word used in the *Exchequer*, signifying old Debts brought together from precedent Years, and put to the present Sheriff's Charge.

**OBLATÆ**; were the Consecrated Wafers or Hosts distributed to the Communicants in the Mass or Sacrament of the Altar; and sometimes the customary Treats in Religious Houses have been called by this Name of *Oblatæ*.

**OBLATIONS of the Altar**, were customary Offerings from the Parishioners to their Priest, which were solemnly laid upon the Altar; of which the Mass or Sacrament Offerings were usually Three-pence at *Christmas*, Two-pence, at *Easter*, and a Penny at the other principal Feasts. The customary Dues also for *Sacramentalia* or Christian Offices, were comprehended under this



Title; and also all little Sums for saying Masses for the Souls of Persons deceased.

**OBLATIONES** *Funerales*, were the *Soul Scent* or Offerings to expiate the Omissions or Defaults of the Party deceased in paying Tythes or other Ecclesiastical Dues: At first this was an Oblation at the Funeral, and was often the best Horse of the Defunct, led before the Corps, and delivered at the Church-Gate or Grave, for the Use of the Parish-Priest.

To this Custom we owe the Original of Mortuaries. If the Corps were buried any where else, the Offerings were due to the Parish-Priest where the Party died.

At the Burial of the Dead, it was a Custom for the surviving Friends to offer liberally at the Altar, for the pious Use of the Priest, and the good Estate of the Soul departed; and the Reliques of this superstitious Custom do still remain in *North-Wales*, where at the Rails of the Communion-Table, there is a Tablet or flat Board fixed, to receive the Money, which at most Funerals is offered by the surviving Friends, according to their own Ability and that of the deceased. *Dr. Kennel's Glossary*.

**OBLIGATION**, is a Bond containing a Penalty, with a Condition annex'd, either for Payment of Money, Performance of Covenants, or the like; and so differs from a Bill that hath no Penalty nor Condition; and yet a Bill may be Obligatory.

**OBLIGATION**, by the Civilians is defined to be a *Cause of Action*, and a legal Bond or Tie which compells by Action to give or to do according to the *Roman Law*. And they divide Obligations into *Natural*, *Civil*, and *Mix'd*: A *natural Obligation* is what arises only from meernatural Equity; and this they distinguish into *Effectual* and *Ineffectual*: The former of which, tho' there is not Ground enough for Action by the *Roman Law*, yet may bar by *Plea* and *Exception*; but the latter hath no Assistance from any positive Law, but consists merely in the Conscience or Pleasure of the Party. A pure *Civil Obligation* owes its Original or Birth to the Strictness of a positive Law, without natural Equity. A *Mix'd Obligation* is a Legal Bond, having its Strength both from Natural and Civil Laws.

**OBLIGOR**, is he that enters into such an Obligation; and *Obligee*, the Person to whom it is entred into.

**OBLIQUATION**, [in *Catoptricks*] as the *Cathetus of Obligation* is a right Line drawn Perpendicular to a narrower in the Point of Incidence, or Reflection of a Ray.

**OBLIQUE angled Triangle**, [in *Geometry*] is that whole Angles are oblique, *i. e.* either obtuse or acute.

**OBLIQUE Line** [*Geometry*] a Line which falling upon another makes an oblique Angle.

**OBLIQUE Ascension**, is that Degree and Minute of the *Equinoctial* which riseth with the Centre of the *Sun* or *Star*, or with any Point of the Heavens, in an Oblique Sphere.

*To find the Sun's Oblique Ascension by the Globe.*

Bring the *Sun's Place* to the Horizon on the East-side; and the Number of Degrees intercepted between that Degree of the *Equinoctial* which

is now come to the Horizon, and the Beginning of *Aries* is the *Oblique Ascension*.

*To find the Oblique Ascension, having the Right Ascension and Ascensional Difference given.*

1. If the Declination be North, the Difference between the *Right Ascension* and the *Ascensional Difference*, is the *Oblique Ascension* required.

2. If the Declination be South, the Sum of the *Right Ascension*, and the *Ascensional Difference*, is the *Oblique Ascension*.

*To find the Oblique Descension.*

1. If the Declination be North, the Sum of the *Right Ascension* and *Ascensional Difference*, is the *Oblique Descension*.

2. If the Declination be South, the Difference between the *Right Ascension*, and the *Ascensional Difference*, is the *Oblique Descension*.

**OBLIQUE Angles**. See *Angles Oblique*.

**OBLIQUE Descension**, is that Part of the *Equinoctial* which sets with the *Sun* or *Star*, or with any Point of the Heavens, in an Oblique Sphere.

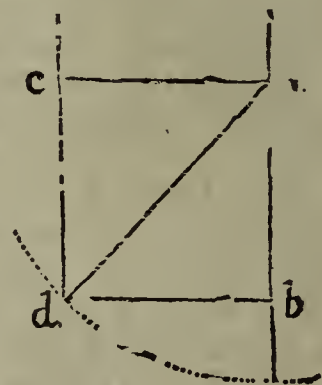
**OBLIQUE Plains**, in Dialing, are such as *recline* from the *Zenith*, or *incline* to the *Horizon*: The Obliquity of which *Inclination* or *Reclination* is easily found by a Quadrant: Being an Ark of some Azimuth or Vertical Circle intercepted between the Vertex of the Place and of that Plane; also observe, this Azimuth or Vertical Circle is always perpendicular to the Plane.

**OBLIQUE Sailing**, is when the Ship runneth upon some Rhumb between any of the four Cardinal Points, making an Oblique Angle with the Meridian; and then she changeth continually both Latitude and Longitude. There are three Kinds of *Oblique Sailing*, viz. *Plain Sailing*, *Mercator's* or *Wright's Sailing*, and *Great Circle Sailing*; which see.

The Seamen call also the Application of the Method of Calculating the Parts of Oblique Plane Triangles, in order to find the Distance of a Ship from any Cape, Head-Land, &c. *Oblique Sailing*.

**OBLIQUE Sphere**, is where the Pole is elevated any Number of Degrees less than 90 Degrees, and consequently the Axis of the World, the Equator, and Parallels of Declination, will cut the Horizon obliquely; whence comes its Name.

**OBLIQUE Force**, is that whose Line of Direction is not at Right Angles with the Body on whom it is imprest. The *Ratio* which such an *Oblique Force* to move a Body, bears to a *Direct* or *Perpendicular Force*, will by this Diagram be easily understood to be always as the *Sine of the Angle of Incidence* is to the *Radius*. Let *a b* be the Side of any Body on which an Oblique Force falls, with the Direction *d a*; draw *d c* at Right Angles to *d b*, a Perpendicular let fall from *d* to the Body to be moved, and make *a d* the Radius of a Circle. 'Tis plain, that the Oblique Force *d a*, by the Laws of Composition and Resolution of Motions will be resolved into the two



Forces



Forces  $d c$  and  $d b$ ; of which  $d c$  being parallel to  $a b$ , hath no Energy or Force to move that Body; and consequently  $d b$  expresses all the Power of the Stroke or Impulse upon the Body to be moved. But  $d b$  is the Right Sine of the Angle of Incidence  $d a b$ ; wherefore the Oblique Force  $d a$ , to one falling perpendicularly is as the Sine of the Angle of Incidence to Radius. *Q. E. D.*

**OBLIQUE Percussion** [in *Mechanicks*] is that, where the Direction of the striking Body is not Perpendicular to the Body that is struck, or that is not in a Line with its Centre of Gravity.

**OBLIQUE Projection** [in *Mechanicks*] is that where a Body is impell'd in a Line of Direction, which makes an *Oblique Angle* with the *Horizontal Line*.

**OBLIQUITY of the Ecliptick.** 'Tis well known that the Plane of the Terrestrial Equator is inclined to that of the Ecliptick in an Angle of 23 Degr. 30 Min. or rather more accurately 23°. 29'. And this Angle (allowing for a very small Nutation of the Earth's Axis, which tho' necessarily deducible from the Principles of the *Newtonian* Astronomy, need not here be considered) hath always yet continued the same: As any one may find if they will on the two Solstitial Days observe the Sun's Meridian Altitudes, and then freeing them from Refractions, Parallax, &c. subtract the Winter from the Summer Altitude; for then half the Difference between them will be found to be 23°. 29'. the Quantity of the Angle of the Inclination or Obliquity of the Ecliptick to the Plane of the Equator.

**OBLIQUUS Superior**, a Muscle of the Head, which ariseth fleshy from the back-part of the transverse Process of the first *Vertebra* of the Neck, and in its somewhat oblique Ascent becometh a fleshy Belly, and lessening itself again, is inserted to the *Os Occipitis* laterally. By this together with its Partner, (they never acting separately) the Head is moved backwards on the first *Vertebra*.

**OBLIQUUS Inferior** is a Muscle of the Head, arising fleshy from the external Part of the Spinal Process of the second *Vertebra* of the Neck, close by the Origination of the *Rectus Major*; and being dilated into a fleshy Belly, passes obliquely to its Insertion at the transverse Process of the First, where the former Muscle begins.

When this acts on either side, the transverse Process of the first *Vertebra* of the Neck is moved towards the Spine of the Second; wherefore some Authors have reckoned it among the Muscles of the Neck. But since the Head is also moved thereby, and the Face turned on that side on which it acteth, it is not improperly reckoned amongst the Muscles that move the Head; it is assisted by the *Mastoidæus*.

**OBLIQUUS Superior**, or *Trochlearis*, is a Muscle of the Eye, which receives its first Denomination from its oblique Position and Course, in regard of the rest of its Fellows. The Second, it derives from that Cartilaginous Ring suspended near the Brink of the upper Part of the Orbit towards the Nose, thro' which its Tendon passes, being reflected on it, as a Rope on a Pulley: Besides which, it is called *longissimus Oculi*, as exceeding the other in Length. Its Use is to help to roll the Eye up and down.

It arises sharp and fleshy from the deepest Part of the Orbit, near the Origination of the *Abducens*, and becoming a fleshy Belly as it passes obliquely close under its superior Part, makes a round Tendon running thro' the *Trochlea*, (as above-mentioned) from whence reverting back, it is inserted to the *Tunica Sclerotis*, in the Middle of the Distance between the Termination of the *Attollens* and Optick Nerve, towards the back-part of the Bulb of the Eye.

**OBLIQUUS Inferior**, is a Muscle called also *Brevissimus Oculi*, it being the shortest Muscle of the Eye. This springs sharp and fleshy from immediately within the lower and almost outward Part of the Orbit, at the Juncture of the First Bone of the upper Jaw, with the Fourth; and becoming thicker, ascends obliquely over the *Deprimens*, growing tendinous at its Insertion to the *Tunica Sclerotis*, near the Implantation of the former, directly betwixt the *Abducens* and Optick Nerves.

Its Use is to help to roll the Eye to and fro, and therefore this and the former are by some called *Circumagentes* and *Amatorii*. Some also reckon two other Muscles belonging to the Eye, which are called by this Name *Oblique*, viz.

**OBLIQUUS Major**, a Muscle that pulls the Eye forwards and obliquely downwards.

**OBLIQUUS Minor**, is a Muscle that pulls the Eye forwards and obliquely upwards.

**OBLIQUUS Ascendens seu Acclivis**, one of the large Muscles of the *Abdomen*, serving to compress the Belly, and by that Means to help the Discharge of the Ordure and Urine; it also compresses and straitens the Cavity of the *Thorax* in Expiration, and helps to turn the Trunk of our Body to either side, when our Feet stand still; and so is a Kind of *Antagonist* to the *Obliquus descendens*, which see.

It arises fleshy from the whole circular Edge of the *Os Ilium* and *Ligamentum Pubis*; and thence mounting with an Order of Fibres, inclining forwards, it forms a broad membranous thin Tendon, which is implanted into the whole Length of the *Linea Alba*, and the Cartilages of the 8th, 9th, 10th, and 12th Ribs.

**OBLIQUUS Descendens seu Declivis**, the Name of one of the large *Epigastrick Muscles*, or Muscles of the *Abdomen*: Besides its Use in common with the rest, to compress the Intestines and Bladder, and to help to exclude the *Fœtus*; Mr. *Cowper* assigns it another, not observed before by any one (except Dr. *Glisson*) which is to move our Body round to either side when our Feet stand still. It arises with several acute Productions, partly fleshy and partly tendinous, from the lower Margin of the Sixth, Seventh, and Eighth Ribs, where its several separate Originations lie between the Indentations of the *Major Anticus*: Besides these, it continues to derive more Heads from the Ninth, Tenth, Eleventh, and sometimes from the Extremity of the lowest Bastard-Rib, where it is also indented with the *Serratus Inferior Posterior*; thence its oblique descending fleshy Part expands itself into a broad membranous Tendon, before it marches over the *Rectus* to its Insertion in the *Linea Alba* and the *Os Pubis*; after this descending, it ends partly tendinous in the *Ligamentum Pubis*, but chiefly fleshy on the upper



upper and fore-part of the circular Edge of the *Os Ilum*.

**OBLIQUUS** *Auris*, is a Muscle of the Ear, which may be also called *Semi-circularis*, from its Position, it lying in the external Parts of the Bony Channel of the *Aquæduct*, whence marching somewhat upwards and backwards, it enters the *Tympanum* in a very oblique Sinuosity excavated immediately above the Bone where the *Tympanum* is incased, and is inserted to the slender Process of the *Malleus*. The Sinuosity in which this Muscle passes, is that which may be taken notice of in the upper Part of the Bony Circle of the *Fæ-tus*. This we don't find described any where, before *Du Verney*.

**OBLONG**, in Geometry, is the same with a Rectangle Parallelogram, whose Sides are unequal.

**OBOLUS**, tho' now taken to signify our half-penny, anciently signified the *Half Noble*. The Noble or *Floren* being called a *Penny*, and its quarter Part a *Farthing*: And indeed in the old Histories and Accounts of Coin, you are to understand by the Word *Denarius*, the whole Coin, be it *Angel*, *Rial*, &c. and by *Obolus* its half; and by *Quadrans* its fourth Part.

**OBSCURA Camera**, in Opticks, is a Room darkened, all but in one little Hole, in which is placed a Glass to transmit the Rays of Objects to a piece of Paper or white Cloth: But by it are made many useful Experiments in Opticks, serving to explain the Nature of Vision; and among which, the following one deserves a particular Description.

*To represent all outward Objects in their proper Colours, Distances and Proportions, on a White Wall, a Frame of Paper, or Sheet hung up for that purpose in a darkened Room.*

This most Wonderful and Glorious Experiment, tho' it be very common, will yet well deserve to have a clear Account given of it here; for I don't remember to have read a plain and intelligible Description of its *Apparatus* any where; neither is it so easie to do it with Advantage, as those perhaps who never tried it may imagine; what follows therefore you may rely on as the Result of my own repeated Experience.

Procure a good Convex, or Plano-Convex Glass, such an one as is made use of for the Object Glass of a Telescope; and if you have a good Telescope that draws about 6 Feet, you may unscrew its Object Glass, and it will serve your Turn very well: And indeed a Glass that draws about that Length (tho' 4 or 5 Foot will do pretty well) is the fittest on all Accounts to make this Experiment withal; for if you use a small Glass whose Focus is not above a Foot, or thereabouts distant from the Hole, the Representation of your Objects will be very small, and the Figures hardly large enough to be distinguished: To which likewise may be added, that not above one Spectator can come to look on it at a Time, and even he not without some Trouble.

On the other hand, if you make use of a Glass which draws 15, 20, or 25 Foot, either your Hole must be very large, and then so much Light

will come in as will hinder the Objects from being visible on the Wall, Paper, &c. or if the Hole be but small, so little Light will come in, that at the Distance of 15 or 20 Foot from the Window, you will have hardly Light enough to see the Representation distinctly; such large Glasses likewise are not easily had every where, nor are they every one's Money; but a Glass that draws about six Feet, is very proper to be made use of in this Case.

Having gotten such a Glass, make Choice of some Room which hath a North-Window, tho' an East or West may do well enough (but a South one will not, for a Reason, to be given below) and let it be well darkened, so that no Light can come into it, but at the Hole where your Glass is placed, or at least but very little. Then make a Hole in the Shutter of the North-Window of about an Inch, or an Inch  $\frac{1}{4}$  in Diameter, and leave open the Casement, if there be one, for there must be no Glass without your Hole. Then fasten the Glass with its Centre in the Centre of the Hole, by some small Tacks to the Shutter, so that no puff of Wind blow it down; and break it; and at the Distance that you know your Glass draws, hang up a white Sheet; or if you do not know exactly the Focus of the Glass, move the Sheet to and fro 'till you find the Objects are represented on it very distinctly, and then you may fasten it there by Nails to the Cieling, &c. Then will whatever is without the Hole, and opposite to it, be represented on that Sheet, with such exquisite Exactness, as far surpasses the utmost Skill of any Painter to express. For if the Sun shine brightly on this Objects (as indeed the Experiment is never made well when it doth not) you will have the Colours of all Things there in their Natural Paint, and such an admirable Proportion of Light and Shadow, as is impossible to be imitated by Art; and I yet never saw any thing of that kind that comes near this natural Landscape. But if the Sun do not shine, the Colours will be hardly visible, and all will look dirty, dark, and confused; therefore I advised a North-Window, that you may have the Meridian Sun shining on your Object in its greatest Splendor, that so the Experiment may be in its greatest Perfection: But you must by no Means have the Sun shine on or near the Hole, for if it doth, all will be confused.

Another Thing, in which this Representation exceeds Painting, is, That here you have *Motion* expressed on your Cloth. If the Wind move the Trees, Plants, or Flowers without, you have it within on your lively Picture; and nothing can be more pleasant than to see how the Colours of the moving Parts will change as they do without, by their being in various Positions obverted to, or shaded from the Light. The Motion of any Flies or Birds, is painted also in the same Perfection: And the exact Lineaments of any Persons walking at a due Distance without the Glass, will be also expressed to the Life, and all their Motions, Postures and Gestures, will as plainly appear on the Cloth, as they do to any one's Eye Without.

In a Word, Nothing is wanting to render it one of the finest Sight in the World, but that all things are inverted, and the wrong End upwards.

To



To remedy which, several Methods have been thought on, as double Convex-Glasses, &c. but none, in my Opinion, are so well, nor so easie, as to take a common Looking-Glass of about 12 or 14 Inches Square, and hold it under or near the Chin, with an acute Angle, to your Breast: For if you do so, and look down into it, you will see all Things upon the Sheet inverted in the Glass, *i. e.* in this Case restored to their natural and erect Position; and this Reflection also from the Glass, gives it a Glaringness that is very surprizing, and makes it look like some Magical Prospect, and the moving Images, like so many Spectrums or Phantasms. And no doubt but there are many Persons that might easily be imposed upon with such a Scene, and who would believe it to be no less than downright Conjurat<sup>o</sup>n.

And I have made use of this Experiment to convince some credulous Persons, that those are abused and imposed upon, who see Faces in the Glasses of some cheating Knaves amongst us, who set up for *Cunning-Men*, and Discoverers of stolen Goods, &c. and have satisfied them, that much more may be done by this, and some other Optical Experiments, and that without the Help of the Devil too, than by the Help of any of the Clumsie Methods used by these Vermin.

If the Glass be placed in a Sphere or Globe of Wood (having an Hole as large as the Glass bored through it) which like the Eye of an Animal may be turned every Way to receive the Rays coming from all Parts of the Objects, it will be of good Advantage to the Experiment; and such, ready fitted, are now commonly sold by Mr. Marshall, at the Archimedes on Ludgate-hill, and are called *Sciopticks*.

And as by this Method any Image may be made appear in a darken'd Room, Dr. Hook, in *Philosoph. Transact.* N. 38. gives a Way of doing the same thing in an Enlightned one, either by Day or Night. The Experiment I have tried myself, and is as follows.

Opposite to the Wall, or Place where the Apparition is to be, let a Hole be made about a Foot in Diameter, or bigger; if there be an high Window that hath a Casement in it, it will do better.

Without this Hole, or Casement, so that the Company in the Room may not see what is done, place the Picture or Object you would represent inverted; and by Means of Looking-Glasses placed behind, if the Picture be *Transparent*, reflect the Rays of the Sun, so that they may pass through it towards the Place where it is to appear; and that no Rays may go besides it, let the Picture be inclosed with a Board or Cloth on every side. If the Object be a Statue or some living Creature, then it must be the more enlightned by casting the Sun-Beams on it by Reflection and Refraction both: Between this Object and the Wall, must be placed a broad Convex-Glass, ground of such a Convexity, that it may represent the Object distinct on the Wall: And therefore, 'tis best to have a clean Linnen Cloth instead of the Wall; which may be hung up any where, according to the Distance of the Glass's Focus. The nearer the Glass is to the Object, the more will the Object

be magnified on the Wall or Cloth; and the further off, the less; which also will depend on the Convexity of the Glass.

If the Object cannot be *Inverted* (as 'tis pretty difficult to do with *Living Animals*, *Candles*, &c.) then there must be two large Glasses of convenient Sphere, and they placed at their appropriated Distances (which are very easily found by Trials) so as to make the Representation erect as well as the Object.

And if the whole Matter be well manag'd, so that the Spectators see nothing of the *Apparatus*, it will be a very surprizing thing to them to see an Image appear by so good a Light on a Plain in the Midst of a Room, where nothing can be discovered that should occasion any such Apparition.

OBSERVATION. The Seamen call an *Observation* the taking the Sun or any Stars Meridian Altitude, in order thereby to find their Latitude; and how they do this you will find under that Word: And they call finding the Latitude by the Name of *Working an Observation*.

OBSERVATORY, [*Observatorium* of *Observare* to observe] a Place fitted for taking Observations of the Heavenly Bodies; or a certain Edifice in the Form of a Tower raised on some Eminence for taking Astronomical Observations.

The more celebrated Observatories are, 1, The *Greenwich* Observatory, built in 1676, by Order of King Charles II. at the Solicitation of Sir Jonas Moor and Sir Christopher Wren; and furnished with the most accurate Instruments by the same; particularly a noble Sextant of 7 Feet Radius, with *Telescope Sights*.

The Person to whom the Province of observing was first committed, was Mr. J. Flamsteed; a Man, who, as Dr. Halley expresses it, seem'd born for the Employment, for the Space of fourteen Years with unwearied Pains he watched the Motions of the Planets; chiefly those of the Moon, as was given him in Charge; that a new Theory of that Planet, exhibiting all her Irregularities, being found, the Longitude might then be determined.

In the Year 1690, having provided himself of a Mural Arch of 7 Feet Diameter, well fix'd in the Plane of the Meridian, he began to verify his Catalogue of the fixed Stars, which hitherto depended altogether on the Distances measured with the Sextant, after a new and very different Manner, viz. by taking the Meridian Altitudes, and the Moments of Culmination, or the Right Ascension and Declination: This Instrument he was so pleas'd with, that he laid the Use of the Sextant almost wholly aside. Thus was the Astronomer Royal employ'd for thirty Years; in the Course of which Time, nothing had appeared in publick, worth so much Expence and Preparation; so that the Observer seem'd rather to have been employ'd for his own Sake, and that of a few Friends, than for the Publick; tho' it was notorious, the Observations that had been made were very numerous, and the Papers swell'd to a great Bulk.

This occasion'd Prince George of Denmark, in the Year 1704, to appoint certain Members of the Royal Society, viz. the Honourable Fr. Roberts, Sir C. Wren, Sir I. Newton, Dr. Gregory, and Dr. Arbuthnot, to inspect Flamsteed's Papers,



and chuse out of them such as they should think fit for the Press; purposing to print them at his own Expence: But the Patron of the Work dying, e'er the Impression was half finished, it lay Still for some time; till at length it was resumed by Order of Queen *Anne*, and the Care of the Press committed to Dr. *Arbutnot*, and that of correcting, and supplying the Copy, to Dr. *Halley*: Such was the Rise and Progress of the *Historia Cœlestis*; the principal Part whereof is the Catalogue of the fixed Stars, called also the *Greenwich Catalogue*.

The *Greenwich Observatory* is found by very accurate Observations to lie in  $51^{\circ} 28' 30''$  North Latitude.

2. The *Paris Observatory* built by the late *Louis XIV.* in the *Fauxbourg St. Jaques*.

It is a very singular, but withal a very magnificent Building; the Design of *M. Perault*: 'Tis 80 Feet high, and a Top is a Terras. 'Tis here *M. de la Hire* has been employ'd.

The Difference in Longitude between this and the *Greenwich Observatory* is  $2^{\circ} 20'$  West.

In it is a Cave, or Cellar, 170 Feet descent, for Experiments that are to be made far from the Sun, &c. particularly such as relate to Congelations, Refrigerations, Indurations, Conservations, &c.

3. *Tycho Brahe's Observatory* was in the little Island *Wœen*, or *Scarlet Island*; between the Coasts of *Schonen* and *Zeland*, in the Baltick.

It was erected and furnished with Instruments at his own Expence, and called by him *Uraniburg*.

Here he spent 20 Years in observing the Stars, the Result is his Catalogue.

*Mr. Gordon*, in *Phil. Transf.* observes, that this was none of the fittest Places for some Kind of Observations, particularly the Risings and Settings; as lying too low, and being Land-locked on all the Points of the Compass but three; and the Land Horizon exceedingly rugged and uneven.

4. *Pekin Observatory*, *Father Le Compte* describes a very magnificent Observatory, erected and furnished by the late Emperor of *China*, in his Capital, at the Intercession of some Jesuits, Missionaries, chiefly *Father Venbienst*, whom he made his Chief Observer.

The Instruments are exceedingly large; but the Divisions less accurate, and the Contrivance, in some Respects, less commodious than those of the *Europeans*: The chief are an *Armillary*, *Zodiacal Sphere* of 6 *Paris Feet* Diameter, an *Equinoctial Sphere* of 6 Feet Diameter, an *Azimuthal Horizon* 6 Feet Diameter, a large *Quadrant* 6 Feet Radius, a *Sextant* 8 Feet Radius, and a *Cœlestial Globe* 6 Feet Diameter.

OBTUSE *Angles*. See *Angles*.

OBTUSE *Angular Section of a Cone*: So the Ancient Geometers, called that Conick Section, which since by *Apollonius*, is called the *Hyperbola*, because they considered it only in such a Cone, whose Section by the Axis is a Triangle Obtuse-angled at the Vertex.

OBTUSE-*Angled Triangle*; see *Triangle*.

OBTURATOR *Externus*, is a Muscle of the Thigh, so called from its Situation; and *Rotator Femoris Extrorsum*, from its Use: It hath a large fleshy Beginning from the External Parts of the *Os Ischium*, and *Pubis*, and the Membrane that covers their *Foramen* externally opposite to

the Origination of the *Marsupialis* or *Obturator Internus*; and passing transversely backwards, lessens itself, and becomes tendinous at its Insertion to the Root of the great *Trochanter* of the Thigh-Bone, near the Termination of the last named Muscle. This turns the Thigh outwards.

OBTURATOR *Internus*. See *Marsupialis*.

OBVENTIONS, signifies Rents or Revenues, properly of Spiritual Livings; as also Offerings.

OCCIDENT, is the West Quarter of the Horizon; or 'tis that Part of the Horizon where the Ecliptick, or the Sun therein descends into the lower Hemisphere: In some Books you will meet with such Terms as these;

OCCIDENT *Estival*, is that Point of the *Horizon*, where the Sun sets at his Entrance into the Sign *Cancer*, when the Days are longest.

OCCIDENT *Hybernal*, is that Point of the *Horizon*, where the Sun sets when it enters into the Sign of *Capricorn*, at which time the Days (with us) are shortest.

OCCIDENT *Equinoctial*, is that Point of the *Horizon*, where the Sun sets when it enters *Aries* or *Libra*.

OCCIDENTAL (*i. e.* Westward) in *Astronomy*, a Planet is said to be *Occidental* when it sets after the Sun.

OCCIPITALIS, and its Partner, are short, but broad, Thin, Fleshy Muscles, situated on the *Occiput*, from whence they derive their Names; when these act, they pull the Hairy-Scalp backwards.

OCCIPITIS *Os*, is a Bone of the *Cranium*, that lies in the hind-part of the Head; it is almost like a Lozenge with its lower Angle turned inwards; it joins the *Offa Parietalia* and *Petrosa*, by the *Sutura Lambdoidalis*: It is thicker than any of the other Bones of the *Cranium*, yet it is very thin where the *Splenius*, *Complexus*, *Trapezius*, are inserted. Externally it is rough, Internally it has two *Sinus's*, in which lie the Protuberances of the *Cerebellum*, and two large Furrows, in which lie the *Sinus Laterales*.

It has Seven Holes: The 1st two are common to it and the *Offa Petrosa*; the lateral *Sinus's* and the *Par vagum*, pass thro' them. The third is the great Hole thro' which the *Medulla Spinalis* passes. The Fourth and Fifth are the Holes thro' which the ninth Pair of Nerves passes. The Sixth and Seventh are two Holes, thro' which there pass two Veins, which bring the Blood from the external Teguments to the *Sinus Laterales*; sometimes there is but one, and sometimes none of these two; there are sometimes two more thro' which the Vertebral Veins pass.

This Bone has also two *Apophyses*, one on each Side of the great Hole; they are lined with a Cartilage and articulated with the first *Vertebra* of the Neck. It has also a small Protuberance in its middle, from which there goes a small Ligament, which is inserted into the first *Vertebra* of the Neck. It is longer in Beasts than in Men.

OCCIPITO-*Frontalis*, is a Muscle of the Skin of the *Occiput* and *Os Frontalis*, which is usually called *Occipitalis*; it arises fleshy from the transverse Line of the *Occiput*, opposite to part of the superior Termination of the *Mastoidæus*, and Part of the Beginning of the *Trapezius* next it, and then tendinous from the rest of the Line backwards



wards, arising after the same Manner on the other side ; from thence it goes strait up, and soon becoming all tendinous, it covers the two *Parietal Bones*, and the *Ossa Squamosa* above the *Temporal Muscles*, its outer Edge being fastned to the *Os Jugale* on each side. This broad Tendon near the *Coronal Suture* grows fleshy and descends with streight Fibres as low as the *Musculi Orbiculares*. It is inserted into the Skin at the Eye-brows having sent down between them a narrow fleshy Slip or Elongation which is continued over the *Ossa Nasi*, as far as its Cartilaginous Parts, where its Fibres run off on each side, and terminate in the Skin above the *Musculus Nasi proprius*. When this Digastrick Muscle, which covers all the upper Part of the Scull like a Cap, acts, it pulls the Skin of the Head backwards, and at the same time draws up and wrinkles that of the Fore-head, and is antagonized by the *Corrugator*.

**OCCIPUT**, [in *Anatomy*] the hinder Part of the Head or Scull; or the Part wherein the *Os Occipitis* is.

**OCCULT**, something secret, hidden, or invisible.

The *Occult Sciences* are *Magic*, *Necromancy*, *Cabbala*, &c.

*Agrippa* has several Books of *Occult Philosophy*, full of the vainest, wildest Dreams; and *Fludd* nine Volumes of the *Cabbala*, or *Occult Science*, wrapt up under Figures, or Hebrew Characters. Weak Philosophers, when unable to discover the Cause of an Effect, and unwilling to own their Ignorance, say it arises from an Occult Virtue, an Occult Cause, an Occult Quality.

*Occult*, in *Geometry*, is used for a Line that is scarce perceivable, drawn with the Point of the Compasses, or a black Lead Pencil.

*Occult*, or *dry Lines*, are used in several Operations ; as the raising of Plans, Designs of Buildings, Pieces of Perspective, &c. They are to be effaced, when the Work is finished.

**OCCULTATION**, in *Astronomy*, is the time that a Star or Planet is hid from our Sight, when eclipsed by the Interposition of the Body of the Moon, or some other Planet between it and us.

**OCCUPANCY**, in the Civil Law, is the Possession of such Things as at present belong to no private Person, but however are capable to be made so; as by seizing or taking of Spoils in War, of things wild by Nature, as Birds and Beasts for Game, &c. or by finding things before undiscovered, or truly lost, or lost by their proper Owners.

**OCCUPANT**. If Tenant *par terme de autre vie dies*, living *Cestuy que vive*; he that first enters shall hold the Land, during the other Man's Life, and he is in Law called an *Occupant*, because his Title is by his first *Occupation*; and so if a Tenant for his own Life, grant over his Estate to another, if the Grantee dies, there shall be an *Occupant*.

**OCCUPATION**, signifies (in Law) the putting a Man out of his Free-hold in time of War, and is all one with *Disseisin* in time of Peace, only it is not so dangerous. 'Tis taken also for Use or Tenure, as when 'tis said, such Land is in the Tenure or *Occupation* of such a Man, that is, in his Possession.

**OCCUPAVIT**, is a Writ, that lieth for him which is ejected out of his Land or Tenement in times of War, as a Writ of Novel *Disseisin* lies for one ejected in time of Peace.

**OCCUPIERS of Walling**, are certain annual Officers in the *Cheshire* Salt-works, who see Right done between Lord and Tenant, and all Persons concerned ; they appoint also how many Houses shall work at a Time, &c. and order a Cryer to proclaim the Time of kindling the Fires, &c. See *Salt*.

**OCEAN**, is the vast Collection or Union of all the Seas which compass round the whole Earth, and in which the two great Continents of *Europe*, *Asia* and *Africa* on one side of the Northern; and *Southern America* on the other, are but like two large Islands. This great and universal Ocean, is sometimes by Geographers divided into 3 Parts ; as 1. The *Atlantick* and *European Ocean*, lying between Part of *Europe*, *Africa* and *America*. 2. The *Indian Ocean*, lying between *Africa*, the *E. Indian* Islands and *New Holland*. The great *South Sea* or the *Pacifick Ocean*, which lies between the *Philippine Islands*, *China*, *Japan*, and *New Holland*, on the West, and the Coast of *America* on the East. Sometimes also with regard to *Europe*, they call that the *Hyperborean Ocean* which encloses it on the North ; and that which encloses it on the West, the *Western Ocean*. That Sea, which encloses *Asia* on the North and East is often called the *Tartarean*, and sometimes the *Chinese Ocean* ; and on the South *Asia* is bounded by three Seas, which are called the *Indian*, *Persian*, and *Arabian Ocean*. Also the great Sea on the East of *Africa*, is called the *Oriental Ocean*, as is also that vast Sea which encloses *America* on the East.

The Surface of the whole Ocean, or of all the Seas of the Globe, Mr. *Keil* computes (in his Examination of Dr. *Burnet's Theory of the Earth*) to be 85490506 square Miles ; and therefore supposing the Depth of the Ocean *Communibus locis* to be  $\frac{1}{4}$  of a Mile, the Quantity of Water in the whole is 21372626 $\frac{1}{2}$  Cubick Miles.

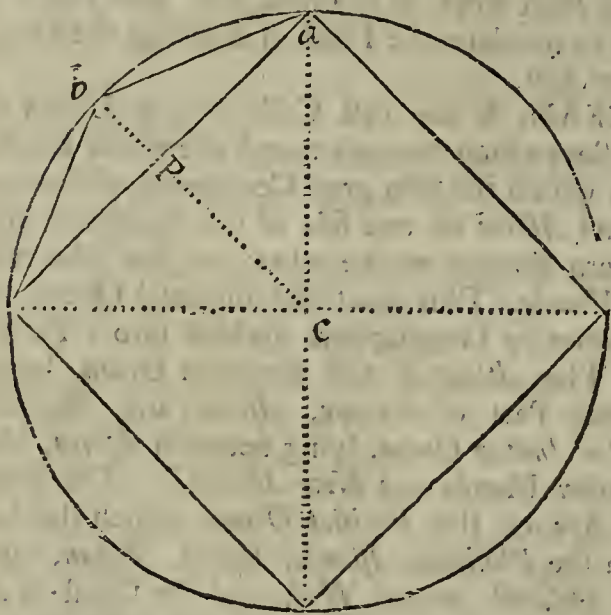
**OCHTHODES**, are Ulcers whose Sides are Callous or of the Nature of Warts, but not malignant. *Blanchard*.

**OCTAGON**, [ὀκτάγωνον] in *Geometry*, is a Figure of eight Sides and Angles. And this when all the Sides are Angles and equal, is called a *Regular Octagon* ; or which may be inscribed in a Circle.



## P R O P O S I T I O N.

The Side of such a Regular Octagon ( $ba$ ) is equal in Power to half the Side of the Square  $ap$ , and to the Difference between that half side and the Radius: (viz.  $b.p.$ ) taken both together.



## D E M O N S T R A T I O N.

That  $ba^2 = bp^2 + pa^2$  is plain from the 47<sup>th</sup> of *Euclid*.

All therefore that is wanting to be proved, is that  $bp$  is the Difference between the half side of the Square and the Radius; which will be very evident when you consider that  $pc$  must be equal to  $pa$ , because the Angle  $a$  and  $c$  being both Semi-Right, must be equal.

OCTANT, or OCTILE, in *Astronomy*, signifies two Planets, &c. being in such an Aspect or Position to another, that their Places differ only an eighth Part of a Circle, or 45 deg. from one another.

OCTAHEDRON; see *Regular Bodies*.

The following Figure being drawn on Past-board, half cut thro, and then folded up will represent an Octahedron.



The Octahedron is two Pyramids put together at their Bases, therefore its Solidity is obtained by multiplying the Quadrangular Base of either (here they are both joined together in the middle of the Figure) by one third of the Perpendicular Height of one of them, and then doubling the Product.

OCTAVE, or Eighth in Musick, is an Interval of Eight Sounds; every Eighth Note in the Scale of the *Gam-ut*, being the same as far as the Compass of Musick requires. Tho' an Humane Voice can reach only to three of these Octaves, but the Tones of the Organ go as far as Eight.

OCTAVES, in old *English* the Uta's were eight Days after any eminent Festival; and such Festivals are enumerated in the Laws of Edward the Confessor.

OCTO Tales; see *Tales*.

OCULUS, in *Botany*, signifies the same with Gemma, or a Bud of a Tree, or any Plant.

OCULUS, the Eye, is the external Organ of the Sight; it is compounded of six Muscles, to wit, of two direct, and as many transverse ones; to which a seventh is added in Brutes. It has seven Tunicks, the Adnata, Innominata, Cornea, Uvea, Retiformis, Crystallina, and Vitrea. It has also the Optick Nerve, the Iris, and the Pupilla. See them singly in their proper Places. *Blanchard*.

How Vision or Sight is made in the Eye. See *Vision* or *Eye*.

OCTOSTYLE, in the antient *Architecture*, the Face of a Building, or Ordonnance, containing 8 Columns.

The 8 Columns of the Octostyle may either be disposed in a Right Line, as in the *Pseudodiptere* Temple of *Vitruvius*, and in the *Pantheon*; or in a Circle, as in the round *Monoptere* Temple of *Apollo Pythius* at *Delphi*, &c.

OCULORUM Motores, a Pair of Nerves arising from the *Medulla Oblongata*, on each side of the *Infundibulum*, and having the *Carotidal Arteries* lying between them: From thence passing thro' the *Foramina Lacera* of the *Os Sphæroides*, they give a Branch, which with a Branch of the fifth pair, forms a considerable Plexus, which sends out several Twigs that embrace the *Optick Nerve*, and are spent on the Tunicks of the Eye; they give a Branch to the Muscles called *Attollens*, *Deprimens*, and *Obliquus Minor*.

ODAXISMUS is the Itching of the Gums when Children breed Teeth. *Blanchard*.

ODIO and *Atia*, was an old Writ mentioned in the Statute of *Westminster* 1. and made 3 E. 1. cap. 11. It was directed to the Sheriff, to enquire whether a Man committed to Prison for a Suspicion of Murder, be committed on just Cause, or only upon Malice: If the latter were the Cause, then another Writ came to the Sheriff to bail him. But now this Course is taken away by 28 E. 3. cap. 9.

ODONTALGIA [of *ὀδονταλγία* of *ὀδὸς* a Tooth and *ἄλγος* Gr. Pain, the Tooth-Ach, which a Pain caused by a sharp Serosity thrown on the Membrane that lines the Sockets, or the *Alveoli* of the Teeth.

ODONTOIDES, that which is like a Tooth, as the Tooth of the second *Vertebra*, and of other Bones. *Blanchard*.

ODOR, by this Word the Ancients did signify sometimes the Sense of Smelling; but now 'tis generally and more properly used for those agreeable or disagreeable Effluvia, which are emitted by many Bodies which are called *Odorous*, and which excite in us the Sensation of Smelling.

ODOURS. That Odours depend very much on the Texture of Odorous Bodies, is plain from this Experiment, that that very Odorous Body *Camphire*, when dissolved and mingled with Oyl of *Vitriol*, will in a Manner quite lose its Scent; but as soon as ever a little Water is poured into the



the Solution, the proper Odour of the *Camphire* will be restored and diffused all around.

OECONOMICKS, [*οικονομική* of *οἶκος* an House and *νόμος* a Law or Rule] that Part of moral Philosophy, which teaches how to manage Affairs of a Family or Community.

OECONOMICUS, was formerly used for the Executor of a last Will and Testament, as the Person, who had the Oeconomy or Fiduciary Disposal of the Deceased's Goods.

ANIMAL OECONOMY, [in *Physick*] the first Branch of the Theory of Medicine, or that which explains the Parts of a Humane Body; the Structure and Use, the Nature and Cause of Life and Health, and the Effects or Phænomena that arise from them.

OEDEMATOUS [in *Medicine*] of, pertaining to or of the Nature of an *Oedema*.

OEDEMA, [*οἰδῆμα* Gr.] is sometimes taken in a large Sence, by *Hippocrates*, for any Tumour; but strictly, for a white, soft, insensible Tumour, proceeding from pituitous Matter heaped up together. It has no Pulse, and yields easily to the Fingers: It may proceed likewise in some Measure from the *Lympha*, or Nutritious Juice extravasated and turned into a Jelly. *Blanchard*.

OESOPHAGÆUS, [*οισοφαγῆς*] or *Sphincter Gulae*, seems to be a Continuation of the Muscle called *Pterigopharyngæus*, arising from each side of the Scuti-formal Cartilage, and like it, passes to a middle Line on the back Part of the *Fauces*.

This do's not assist the *Pterigopharyngæus* in compressing the masticated Aliment into the *Gula*; but is thought by some to strengthen the *Scuti-formis*, and render the Tone of the Voice more acute.

OESOPHAGUS, [*οισοφάγος* Gr.] the Gullet, is the Pipe or Funnel, that conveys the Meat into the Stomach. It is an Organical Part of the Body, round and hollow, beginning at the Root of the Tongue behind the *Larynx*, (which Part of it is called *Pharynx*) and descendeth from thence directly, between the Windpipe and *Vertebrae* of the Neck, and the four first *Vertebrae* of the *Thorax*, upon which it resteth; but when it is come to the Fifth *Vertebra* it giveth way to the descending Trunk of the great Artery, by bending a little to the Right side; afterward accompanying the Artery down to the ninth *Vertebra*, there it turns a little to the Left again, and climbs upon the Artery; and by and by, about the eleventh *Vertebra*, it passeth thro' the Midriff, a little on the Left Side of its Nervous Centre, at a Hole distinct from that of the great Artery, and is inserted or continued into the Left Orifice of the *Ventricle*.

It is composed of three *Membranes*; the outmost is common to it and the Stomach, and is very thin, being endowed only with Membranous Fibres, and those very slender. Some derive its Origin from the *Midriff*, some from the *Pleura*, and some from the Ligaments of the *Vertebrae* of the Neck and Breast, upon which it resteth: All which Opinions (according to Dr. *Glisson*) may be true, if they be intended only of an Origin of Continuation or Connexion, seeing it is continued plainly to the Three first, and knit to the last; but none of them is true, if they be intended

of a sustaining or maintaining Origin, or of a Principle of Influence. The Second or Middle is fleshy and thick, and consists of two Ranks of fleshy Fibres, which ascend and descend obliquely, (spiralwise) and do mutually intercussate or cross one another, so as that the Fibre, which, before it met with another to intersect, did lie underneath another, rides upon that which it intersects, and so continues uppermost, till it comes to a second, and so on by Turns. The Third or Innermost is endued with slender strait Fibres, and those only, as Ancient Anatomists have taught; but Dr. *Willis* affirms it to have Fibres of divers Kinds, and those diversly woven one with another. It is wholly nervous, saving a certain hoary or downy Substance that cloaths its Inside. It is continued to that Membrane that covereth the Mouth, Jaws and Lips; and (according to Dr. *Willis*) it descends Three Fingers Breadth below the Mouth of the Stomach.

From its being thus common to the Mouth, Gullet, and upper Orifice of the Stomach, proceeds that great Consent among these Parts in Vomiting, &c.

It hath *Veins* in the Neck from the Jugulars, in the *Thorax* from the *Vena sine pari*; but where it is joined to the Stomach, it hath some Twigs from the *Ramus Coronarius*, which is a Branch of the *Vena Portæ*.

It hath *Arteries* in the Neck from the *Carotides*; in the *Thorax*, from the *Intercostals*; and in the *Abdomen*, from the *Ramus Cæliacus coronarius*.

*Nerves* it hath from the *Par vagum* or Eighth Pair.

It hath Four *Glandules*; Two in the Throat, which are called *Tonsillæ*, or Almonds, common to it and the *Larynx*, which separate a mucous or pituitous Humour to moisten them. Other Two it hath near its middle, on its out and backside, about the Fifth *Vertebra* of the *Thorax*; namely, where it gives way to the Trunk of the *Aorta*, and turns somewhat to the Right side, or at the Place where the *Aspera Arteria* is divided into two Branches. These are as big, each of them, as a Kidney Bean, and of the same Shape; but sometimes there are more than two, and then they are less: They are soft and fungous; and their Use hath been reckoned to be for the separation of a Juice to moisten the Gullet. But Dr. *Wharton* rejects this Opinion, because there appear no excretory Vessels that might convey the Liquor that is separated in them to within the Gullet. However, tho' such Vessels do not appear, yet it is more probable that they serve for that Use, than for that which he assigns to them, viz. to draw out from the *Lympha*, that runs through them, that Juice which is more mild and fit for Nourishment, for the Use of the Nerves that are fastened to them; or to deposite the Remainder into the common *Chyliferous Duct* by a Pipe, which he supposeth there must be, but does not describe.

The Gullet serveth as a Conduit to convey Meat and Drink by from the Mouth to the Stomach; for these being turned down into the Throat by the Tongue, all the Membranes of the *Pharynx* are relaxed for the Reception thereof; and presently the same are squeezed down the



Gullet, by the Constriction of its middle Coat, and the Muscles of the *Pharynx*.

OESTRUM *Veneris*, Extasy of Desire or Love; a Term sometimes given to the *Clitoris* from the lascivious Titillation it is capable of.

OFFA *Alba*. So *V. Helmont* calls a white Coagulation which will arise, if equal Parts of highly Rectified Spirits of Wine and Urine be mixed and shaken together; but the Spirit of Urine must be distilled from well-fermented Urine, and it must be truly dephlegmated, or else it will not succeed.

OFFERTORIUM, formerly was used for a Piece of Silk or fine Linnen, to receive and wrap up the Oblations or occasional Offerings in any Church.

OFFICE, signifies not only that Function, by Virtue whereof a Man hath some Employment in the Affairs of another; but also an Inquisition made to the King's Use of any thing, by Virtue of his *Office*, who enquireth; And therefore we oftentimes read of an Office found, which is nothing else but such a thing found by Inquisition made *ex Officio*. And 'tis used in this Sense in 33 H. 8. 20. and in *Stamf. Prærog.* Fol. 6. 61. Where to *traverse an Office*, is to traverse the Inquisition taken of an Office. And in *Kitchin*, Fol. 177, to *return an Office*, is to return that which is found by Virtue of the Office. And there are two Sorts of Offices, in this Signification, issuing out of the *Exchequer* by Commission, viz. An Office to entitle the King to the Thing enquired of, and An Office of Instruction. Office in Fee, is that which a Man hath to himself and his Heirs.

OFFICIAL. This Word, by the Ancient Civil Law, signified him that was the Minister or Apparitor of a Magistrate or Judge. In the Canon Law it is especially taken for him to whom any Bishop doth generally commit the Charge of his Spiritual Jurisdiction: And in this Sense, one in every Diocese is *Officialis Principalis*, whom the Statutes and Laws of this Kingdom call *Chancellor*: The rest, if there be more, are by the Canon Law called *Officiales Foranei*, but in Common Law *Commissioners*. The Difference of the Two Powers you'll find in *Linwood, Tit. de Sequestra Possess.* cap. 1. *verbo Officialis*. And this Word *Official*, in our Statutes and Common Law, signifies him whom the Arch-deacon substituteth in the executing of his Jurisdiction.

*Officiatus non faciendis vel amovendis*, is a Writ directed to the Magistrates of a Corporation, willing them not to make such a Man an Officer, and to put him out of the Office he hath; until Enquiry be made of his Manners, according to an Inquisition formerly ordained.

Offices, with Regard to Architecture, are all the Lodges and Apartments, that serve for the necessary Services and Occasions of a great House or Palace; particularly those which have a Relation to Eating; as Kitchens, Pantries, Brew-houses, Confectionaries, Fruiteries, Granaries, &c. as also Wood-houses, Equerries, &c.

The Offices are commonly in the Basscourts, sometimes they are sunk under Ground, and well vaulted, &c.

OFF-SETS, in surveying, are Perpendiculars let fall, and measured from the Stationary Lines, or the Lines between one Station and another,

to the Hedge, Fence, or Extremity of the Inclosure.

OFFIN. So the Seamen call that Part of the Sea, which is a good Distance from Shoar, where there is deep Water, and no need of a Pilot to conduct the Ship into the Port. Thus if a Ship from Shoar be seen sailing out to Sea-ward, they say she stands for the *Offin*; and if a Ship having the Shoar near her, have another a good way without her, or towards the Sea, they say that Ship is in the *Offin*.

OFF-WARD. If a Ship, being a-ground by the Shore, doth heel towards the Water-side, they say she heels to the *Off-ward*; so if she lie with her Stern only to Sea-ward, they say she lies with her Stern to the *Off-ward*, and her Head to Shoar-ward.

OGEE, *Ogive*, and as it is often written O---G--- is a Sort of Moulding in Architecture, consisting of a Round and a Hollow. *Vitruvius* makes it two Quarter Circles. *Scamozzi* and some others make the Arches flatter. 'Tis almost in the Form of an S, and is the same with what *Vitruvius* calls *Cima*. *Cima Reversa* is an O---G--- with the Hollow downwards, as some define it.

OGRESSES, a Term in Heraldry; the same with *Pellets*, which see.

OIL, which the Chymists call *Sulphur*, is the Second of their *Hypostatical* and of the true Five Chymical Principles. 'Tis an inflammable, unctuous, subtile Substance, which usually rises after the Spirit. The Chymists attribute to this Principle all the Diversity of Colours, and all the Beauty and Deformity of Bodies: Probably their various Odours do in a great Measure arise from it. And it sweetens the Acrimony of Salts; and by stopping or filling up the Pores of a mixt Body, keeps it longer from Corruption, where it abounds. And we find that the *Ever-Greens*, such as *Box*, *Holly*, &c. do abound more with Oil than other Plants.

There are two sorts of Oils; One, which seems to be mixt with Spirit, (for it can never be drawn pure) and which will swim upon Water; such as Oil of Anniseeds, Lavender, Rosemary, &c. which the Chymists call *Essential*, and is commonly drawn in a Limbeck with Store of Water. And another Kind, which probably is mixed with Salts, and these will sink in Water; such as the Oils of ponderous Woods, as *Guaiacum*, *Box*, *Cloves*, &c.

There are some things, which are very improperly called Oils; as *Oil of Tartar per Deliquium*, which is only a fixed Salt dissolved. *Oil of Vitriol*, which is nothing but the most caustick and strongest Part of the Spirit of Vitriol. *Oil of Antimony*, which is only a Mixture of Antimony and an Acid Spirit.

Mr. *Boyle* to shew the Producibleness of Chymical Principles, tells us, that by mixing carefully and gradually together an equal Weight of Oil of Vitriol, and truly rectified Spirit of Wine; and then, by a very wary Management of the Fire, drawing off what will come over, he could obtain (besides a subtil odoriferous Spirit, and an acid and sulphurous Liquor) a considerable Quantity of Chymical Oil, sometimes deeply coloured, sometimes pale like Water, and sometimes exceeding fragrant, and without any Acidity



ty in it at all ; yet was so ponderous, as not only to sink in Water, but even in the acid Spirit, which was drawn off with it, and seems to be the Oil of Vitriol only altered and exalted ; nor would this Anomalous Oil at all mingle with Water, tho' both the Oil and Spirit, from whence it was distilled, would readily do so.

**OIL of Philosophers.** So the Vapouring Chymists call a Distillation in a Retort of Pieces of Brick heated red hot, and then cast (while so) into Oil of Olives, the Bricks will imbibe a good deal of Oil ; which Oil being afterwards drawn from them again, is their *Oil of Bricks* or *Oil of Philosophers* ; and they attribute great Virtues to it.

**OIL of Sulphur per Campanam.** See *Spirit of Sulphur*.

**OIL of Tartar per Deliquium,** is a fixt Salt of Tartar dissolved, by being exposed to the Air in a cool moist Place.

**OIL of Vitriol,** improperly so called, is what remains in the Cucurbite after the Distillation of Vitriol is rectified, and the Sulphureous and Acid Spirit both drawn off ; 'tis the more fixt Part of the Spirit of Vitriol, rendered Caustick by a vast Degree and Continuance of Fire. 'Tis used in the Dissolution of Metals, and sometimes given inwardly, when in a small Dose, and duly diluted.

This Oil, if it be mingled either with Spirit of Vitriol, common Water, or any *Ethereal Oil*, as the Chymists call Oil of Turpentine, &c. it will grow so very hot, as often to break the Vial that contains the Mixture.

**OLEAGINOUS,** Oily, or pertaining to the Nature of Oil : Thus in Soap, which is made of Oil, (or Grease) Salt and Water ; we say there are some *Oleaginous*, some *Saline*, and some *Aqueous* Parts.

**OLECRANUM,** [ὀλέκρανον Gr.] or *Ancon*, is the greater Process of the first Bone of the Cubit called *Ulna* ; also the upper Part of the Shoulder. *Blanchard*.

**OLERON Laws,** are so called, because made when King *Richard I.* was there (*i. e.* at *Oleron*, an Island in the Bay of *Aquitain* in *France*.) They have Respect to Maritime Affairs.

**OLIGOTHROPUS** (*Cibus*) is Meat that nourishes little, to which is opposed *Polytrophus*, that which affords much Nourishment. *Blanchard*.

**OLIGOTROPHY,** [ὀλιγοτροφία of ὀλίγον little and τροφή Gr. Food] is a Decrease of Nutrition ; or a very small one.

**OLFACTORY Nerves,** or those which give us the Sense of Smelling, are the first Pair of those Ten which arise from the *Medulla oblongata* : They come from the Basis of the *Corpora Striata*, and passing through the little Holes of the *Os Cribriforme*, they are spread upon the Membrane which covers the *Os spongiosum*.

**OLIVARIA Corpora,** are two Protuberances of the under Part of the Brain, placed on each side of the *Corpora Pyramidalia*, towards the lower End ; having their Name from their Figure, which is like that of an *Olive*.

**OLOR.** See *Cygnus*.

**OLYMPIAD,** a Term in Chronology, signifying the Space of Four Years, or Fifty Months, reckoning Thirty Days to a Month ; from whence the Ancient *Grecians* derived their Account of Time. This Kind of Computation took

its Rise from those famous *Olympick Games* which were celebrated every fifth Year, in the Festival Solstice, during Five Days on the Banks of the River *Alpheus*, near the City *Olympia*, where the noted Temple of *Jupiter Olympicus* stood. The first *Olympiad* began about 500 Years after the Destruction of *Troy*, in the 3938 Year of the *Julian Period*, *A. M.* 3174, and 766 Years before Christ.

**OLYMPICK Jure,** A Name given to the Rays of the Sun collected in the *Focus* of a Burning Glass.

**OMENTUM, Rete, or Reticulum,** the Cawl, is a double Membrane arising from the *Peritoneum*, or as some say, from the *Mesentery* ; spread upon the Intestines or Guts, interwoven with fat and small Vessels like a Fisher's Net, enriched also with two or three Glandules ; on the Fore-part it is annexed to the Bottom of the Stomach, to the Gut Colon, to the Spleen ; and sometimes to the *Pancreas*, and the round Lobe of the Liver.

Its Use is to cherish the Intestines with its Warmth, and to facilitate the Concoction of the Aliments in the Guts, as well as to knit loosely the Stomach, Spleen, Pancreas, Colon, &c. together.

It hath some Milky and Lymphatick Vessels, as also a great many *Ductus's*, and little Bags of Fat.

**OMOPLATA,** and *Homioplata*, the same with *Scapula*.

**OMPHALMICUS,** is a Branch of the Fifth Pair of Nerves which move the Eye.

**OMPHALOCÉLE,** [of ὀμφαλός a Navel and κῆλη Gr. a Tumour] is a Rupture about the Navel, to wit, when the Cawl or Intestines are Protuberant in that Part ; which happens from a Relaxation, or bursting of the *Peritonæum*.

**OMPHALO Mesentericks** [in *Anatomy*] certain Blood Vessels, as a Vein and an Artery, that a Dog, Cat, a Hare, &c. has, in which the *Fœtus's* are wrapped, so called, because they pass a long the String to the Navel.

**OMPHALOPTICK** [of ὀμφαλός a Navel and ὀπτικός Gr.] an Optick Glass, that is Convex on both Sides, commonly called a Convex Lens.

**ONERANDO pro rata portionis,** is a Writ that lies for a Joint-Tenant, or Tenant in common, that is distrained for more Rent than his Proportion of the Land cometh to.

**ONI.** In the *Exchequer*, as soon as a Sheriff enters into his Accompts, for Issues, Amerciaments, and mean Profits, they set upon his Head this Mark, *Oni*, which denotes *Oneratur, nisi habet sufficientem exonerationem* ; and thereupon he forthwith becomes the King's Debtor, and a Debt is set upon his Head ; and then the Parties *Peravayle* become Debtors to the Sheriff, and discharged against the King.

**ONKOTOMY** [of ὄγκος a Tumour and τέμνω Gr. to cut] the Operation of opening a Tumour or abscess.

**ONOMATOPOEA,** [ὀνοματοποιία of ὄνομα a Name ποιέω Gr. to feign] a Figure in Grammar whereby Names and Words are formed to the Resemblance of the Din or Sound, made by the Thing signified, as the *Buzzing* of Bees, the *Grunting* of Hogs, &c.

**ONTOLOGY ONTOSOPHY,** [of ὄντος gen. of



of being and *λέγω* Gr. to say, or of *ὄντες* and *σοφία* Gr. Wisdom] the Doctrine or Knowledge of being or *de Ente* in the General or Abstract.

ONYCHOMANCY, [*ὄνυξ* the Nail of the Hand and *μαντεία* Gr. Divination] a Kind of Divination by the Nails of the Fingers.

ONYX, the same with *Hypopyon*, a gathering of Matter under the *Tunica Cornea* of the Eye.

OPACITY. Sir *Is. Newton*, *Opticks*, Book 2 shews that the *Opacity* of all Bodies ariseth from the Multitude of Reflections caused in their Internal Parts: And he shews also, that between the Parts of the opaque and coloured Bodies, there are many Spaces either empty or replenished with Mediums of other Densities; and he shews the true or principal Cause of *Opacity* to be this discontinuity of their Parts; because some opaque Bodies become transparent by filling their Pores with any Substance of equal or almost equal Density with their Parts. Thus Paper dipped in Water or Oil, the *Oculus Mundi* Stone steep'd in Water, Linnen Cloth oiled or varnished, and many other Substances soaked in such Liquors as will intimately pervade their little Pores, become by that Means more transparent than otherwise; as on the contrary, the most transparent Substances may, by evacuating their Pores or separating their Parts, be render'd sufficiently opaque; as Salts or wet Paper, or the *Oculus Mundi* Stone by being dried, Horn by being scrap'd, Glass by being powder'd or flaw'd, Water by being form'd into small Bubbles either alone in the Form of Froth, or by shaking it together with Oil of Turpentine, or some other convenient Liquor with which it will not perfectly incorporate.

But however to render Bodies opaque and coloured, their Interstices must not be less than of some definite Bigness; for the most *opacous* Bodies that are, if their Parts be subtilly divided (as when Metals are dissolved in acid Menstruums) become perfectly transparent. And on this Ground it appears, why Water, Glass, Salt, and some Stones are transparent, for they are as full of Pores and Interstices as the Bodies are; but yet their Parts and Interstices are too small to cause Reflections in their common Surfaces: Wherefore white Metals become opaque not from their Density alone, but from their Parts being of such a Bigness as fits them to reflect the White of the first Order. And as he shews, that the White of the first Order is the strongest which can be made by Plates of transparent Substances, so it ought to be stronger in the denser Substances of Metals than in the rarer ones of Air, Water and Glass. And he thinks that metallick Substances of such a Thickness as may fit them to reflect the White of the first Order, may by Reason of their great Density reflect all the Light incident upon them, and so be as opaque and splendent as 'tis possible for any Body to be. See *Colours*.

OPACOUS Bodies, are such whose Pores (probably) lying in an oblique and crooked Position, the Rays of Light cannot freely permeate and pass through them, as they do thro' transparent ones; wherefore if you hold them up against the Light, you cannot see through them.

OPEN Flank, in Fortification, is that Part of the Flank, which is covered by the Shoulder or Orillon.

OPENING of the Gates [in *Astrology*] is when one Planet separates from another, and immediately applies to a third, which bears Rule in a Sign opposite to that ruled by the Planet, with which it was joined.

OPENING of the Trenches; is the first breaking Ground of the Besiegers, in order to carry on their Attacks against the Town. The Difference between this and *carrying on the Trenches*, is that *this* is only the Beginning of the Trench: It is begun by a small Foss or Ditch, which the Pioneers make in the Night on their Knees, usually about a Musket-shot from the Place; but if there be no hollow nor rising Ground to favour them, they begin farther off. This small Foss is afterwards enlarged by the next Pioneers which come behind the first; and so 'tis dug deeper by Degrees till it be about 12 Feet broad and 5 Feet deep. The Earth that is dug out is thrown up as they go along, and serves them for a Parapet to save them from the Fire of the Town. The Place where the Trenches are opened, is called the End of the Trench.

OPERA, is a Sort of solemn Entertainment of Musick upon the Theatre or Stage, and is very common in *France* and *Italy*: It usually begins with an *Ouverture*, which commonly ends with a *Fugue*; the rest is composed of *Symphonies*, *Recitativo's*, *Chacoons*, *Preludes*, &c. with all Sorts of Vocal and Instrumental Musick.

OPHIASIS, [*ὀφίασις* Gr.] is a Disease where the Hairs grow thin and fall off here and there, so that they leave the Head spotted like a Serpent. *Blanchard*.

OPHIUCUS, [*ὀφιούχος*] one of the Northern Constellations, the same with *Serpentarius*: It contains 30 Stars, one of which in the Head of the Man holding the Serpent, is of the second Light or Magnitude.

OPHTHALMICKS, [*ὀφθαλμικά* of *ὀφθαλμός* Gr. an Eye] are such Medicines as are good for Diseases in the Eyes.

OPHTHALMOGRAPHIA, [*ὀφθαλμογραφία* of *ὀφθαλμός* an Eye and *γραφία* Gr. a Description] that Branch of Anatomy that considers the Structure and Composition of the Eye, the Use of the several Parts, and the Principal Effects of Vision.

OPHTHALMOSCOPIA, [*ὀφθαλμοσκόπια* of *ὀφθαλμός* and *σκοπέω* Gr. to view] That Branch of Physiognomy, that considers a Person's Eyes, in order from them to discover, and gain the Knowledge of his Temperament, Humour and Manners.

OPIATES, are Medicines made of *Opium*, or something of the same Nature with it, designed to cause Sleep, and to ease Pain: When they produce the latter Effect, they call them *Anodynes*, when the former, *Hypnoticks*; and when they cause a very great Sleep or Stupor, *Narcoticks*. The foreign Physicians confound an *Opiate* and an *Eleutary*; see *Blanchard* on the Word *Opiata*.

OPISTHOTONUS. See *Posticum*.

OPISTHOTONUS, [*ὀπισθότονος* Gr.] or *Tetanus*, is a Kind of Cramp, or stretching of the Muscles of the Neck backwards; which proceeds sometimes from a Palsie of the Muscles of the Neck, whereupon the Antagonists or opposite Muscles move the intermediate Parts too much;



or from a sharp and ferous Matter in the Tendons; or from the Animal Spirits which enter the fleshy Pipes more than usual, and will not easily recede, so that the Parts are swelled and wrinkled up. *Blanchard.*

**OPPILATION**, [in *Physick*] the Act of obstructing or stopping up the Ducts, or Passages of the Body by peccant Humours.

**OPPOSITE Cones**, are two Similar Cones vertically opposite, and having the same common Axis. And

**OPPOSITE Sections** are the two *Hyperbola's* made by a Plane cutting both those Cones. See the Figure under the Word *Latus Transversum*, where the Cones VAD and BVA are opposite, and the Sections ODO, OEO, are opposite *Hyperbola's*.

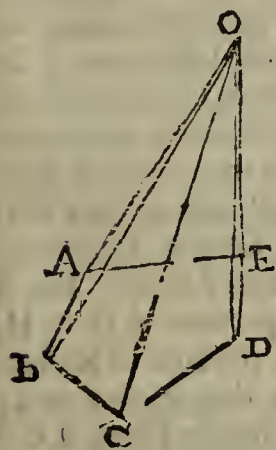
**OPPOSITE Sections**. If a Cone be cut by a Plane through its Vertex, and afterwards by a second Plane parallel to the former, this latter Plane produced through the opposite Cone, will there make the opposite Sections. See *Conick Sections*.

**OPPOSITION**, is that Position or Aspect of the Stars or Planets, when they are 6 Signs, or 180 Degrees distant from one another, and is marked thus 8.

**OPTATIVE Mood**, (in Grammar) is the way of forming a Verb so, as that it may express an ardent Desire that such a Thing may happen; and therefore there is usually an Adverb of wishing connected with it, as *utinam* &c.

**OPHTHALMY**, [*ὀφθαλμία* Gr.] is an Inflammation of the Tunicks of the Eyes, proceeding from Arterious Blood, collected and extravasated there, because it cannot return by the Veins. *Blanchard.*

**OPTICK Pyramid** is made by Rays coming from the several Angles of the superficial Base of any Object, and united in a Point in the Eye of the Spectator. Thus if A B C D E be the Base of the Eye in O, the Optick Pyramid O A B C D E O. And when the Base is a Right-Line, as suppose A E or C D, then the Triangle O A E or O C D is called the



**OPTICK Triangle**, as the Angle A O E or C O D, is called the *Optick Angle*.

**OPTICKS**, [*ὀπτική* of *ὀπτομαί* Gr. to see] is a Mathematical Science that treats of the Sight in general, and of every thing that is seen with *direct Rays*; and explains the several Properties and Effects of Vision in general, and properly of that which is direct and ordinary. For when the Rays of Light are considered as reflected, the Science which teaches their Laws and Properties, is called *Catoptricks*; and when the Refraction of Rays is considered, and the Laws and Nature of it explained and demonstrated, the Science is called *Dioptricks*. So that *Opticks* comprehends the Whole; of which *Catoptricks* and *Dioptricks*, are the two Parts.

**OPTICKS**, taken properly and simply, is that Science which teaches the Properties of direct Vision; but in a larger Sense it may compre-

hend the whole Doctrine of Light and Colours, and all the Phænomena of Visible Objects. In this large Sense our incomparable Sir *Is. Newton* calls his Book of Light and Colours, *Opticks*; and from thence the following brief Introduction to this Science is taken.

## DEFINITIONS.

### DEFIN. I.

*By the Rays of Light I understand its least Parts, and those as well successive in the same Lines as contemporary in several Lines. For it is manifest that Light consists of Parts both successive and contemporary; because in the same Place you may stop that which comes one Moment, and let pass that which comes presently after; and in the same time you may stop it in any one Place, and let it pass in any other. For that Part of Light which is stoppt cannot be the same with that which is let pass. The least Light, or part of Light, which may be stoppt alone without the rest of the Light, or propagated alone, or do or suffer any thing alone, which the rest of the Light doth not or suffers not, I call a Ray of Light.*

### DEFIN. II.

*Refrangibility of the Rays of Light, is their Disposition to be refracted or turned out of their Way in passing out of one transparent Body or Medium into another. And a greater or less Refrangibility of Rays, is their Disposition to be turned more or less out of their Way in like Incidencies on the same Medium. Mathematicians usually consider the Rays of Light to be Lines reaching from the luminous Body to the Body illuminated, and the Refraction of those Rays to be the bending or breaking of those Lines in their passing out of one Medium into another. And thus may Rays and Refractions be considered, if Light be propagated in an Instant. But by an Argument taken from the *Æquations* of the Times of the Eclipses of *Jupiter's Satellites* it seems that Light is propagated in time, spending in its Passage from the Sun to us about seven Minutes of Time: And therefore I have chosen to define Rays and Refractions in such general Terms as may agree to Light in both Cases.*

### DEFIN. III.

*Reflexibility of Rays, is their Disposition to be turned back into the same Medium from any other Medium upon whose Surface they fall. And Rays are more or less reflexible, which are turned back more or less easily. As if Light pass out of Glass in to Air, and by being inclined more and more to the common Surface of the Glass and Air, begins at Length to be totally reflected by that Surface; those Sorts of Rays which at like Incidencies are reflected most copiously, or by inclining the Rays begin soonest to be totally reflected, are most reflexible.*

### DEFIN. IV.

*The Angle of Incidence, is that Angle which the Line described by the incident Rays contains with the*



*Perpendicular to the reflecting or refracting Surface at the Point of Incidence.*

## D E F I N. V.

*The Angle of Reflexion or Refraction, is the Angle which the Line described by the reflected or refracted Ray contained with the Perpendicular to the reflecting or refracting Surface at the Point of Incidence.*

## D E F I N. VI.

*The Sines of Incidence, Reflexion and Refraction, are the Sines of the Angles of Incidence, Reflexion, and Refraction.*

## D E F I N. VII.

*The Light whose Rays are all alike Refrangible, I call simple, Homogeneous and Similar; and that whose Rays are some more Refrangible than others, I call Compound, Heterogeneous, and Dissimilar. The former Light I call Homogeneous, not because I would affirm it so in all Respects; but because the Rays which agree in Refrangibility, agree at least in all those their other Properties, which I consider in the following Discourse.*

## D E F I N. VIII.

*The Colours of Homogeneous Lights, I call Primary, Homogeneous and Simple; and those of Heterogeneous Lights, Heterogeneous and Compound. For these are always compounded of the Colours of Homogeneous Lights; as will appear in the following Discourse.*

## A X I O M S.

## A X. I.

*The Angles of Incidence, Reflexion, and Refraction, lie in one and the same Plane.*

## A X. II.

*The Angle of Reflexion is equal to the Angle of Incidence.*

## A X. III.

*If the refracted Ray be returned directly back to the Point of Incidence, it shall be refracted into the Line before described by the Incident Ray.*

## A X. IV.

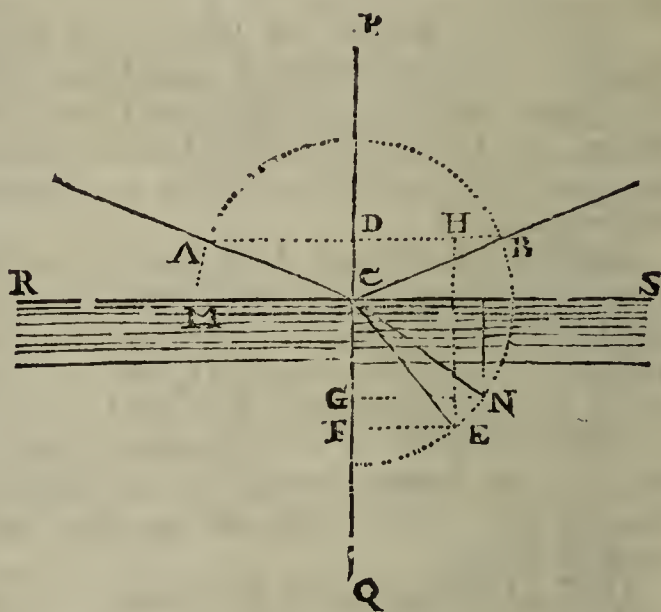
*Refraction out of the rarer Medium into the denser, is made towards the Perpendicular; that is, so that the Angle of Refraction be less than the Angle of Incidence.*

## A X. V.

*The Sine of Incidence is either accurately or very nearly in a given Ratio to the Sine of Refraction.*

Whence if that Proportion be known in any one Inclination of the incident Ray, 'tis known in all

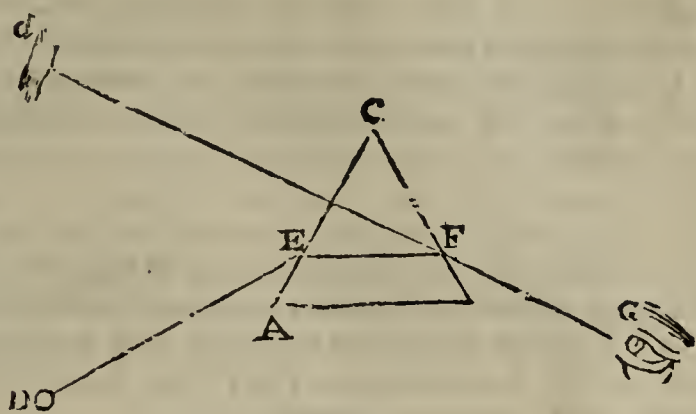
the Inclinations, and thereby the Refraction in all Cases of Incidence on the same refracting Body may be determined. Thus if the Refraction be made out of Air into Water, the Sine of Incidence of the red Light is to the Sine of its Refraction as 4 to 3. If out of Air into Glass, the Sines are as 17 to 11. In Light of other Colours the Sines have other Proportions; but the Difference is so little, that it need seldom be considered.



Suppose therefore, that R S represents the Surface of stagnating Water, and C is the Point of Incidence in which any Ray coming in the Air from A in the Line A C is reflected or refracted, and I would know whither this Ray should go after Reflexion or Refraction: I erect upon the Surface of the Water from the Point of Incidence the Perpendicular C P and produce it downwards to Q, and conclude by the first Axiom, that the Ray after Reflexion and Refraction, shall be found somewhere in the Plane of the Angle of Incidence A C P produced. I let fall therefore upon the Perpendicular C P the Sine of Incidence A D, and if the reflected Ray be desired, I produce A D to B, so that D B be equal to A D, and draw C B. For this Line C B shall be the reflected Ray, the Angle of Reflection B C P and its Sine B D being equal to the Angle and Sine of Incidence, as they ought to be by the second Axiom. But if the refracted Ray be desired, I produce A D to H, so that D H may be to A D as the Sine of Refraction to the Sine of Incidence, that is, as 3 to 4; and about the Center C and in the Plane A C P with the Radius C A describing a Circle A B E I draw parallel to the Perpendicular C P Q, the Line H E cutting the Circumference in E, and joining C E, this Line C E, shall be the Line of the refracted Ray. For if E F be let fall perpendicularly on the Line P Q, this Line E F shall be the Sine of Refraction of the Ray C E, the Angle of Refraction being E C Q; and this Sine E F is equal to D H, and consequently in Proportion to the Sine of Incidence A D as 3 to 4.

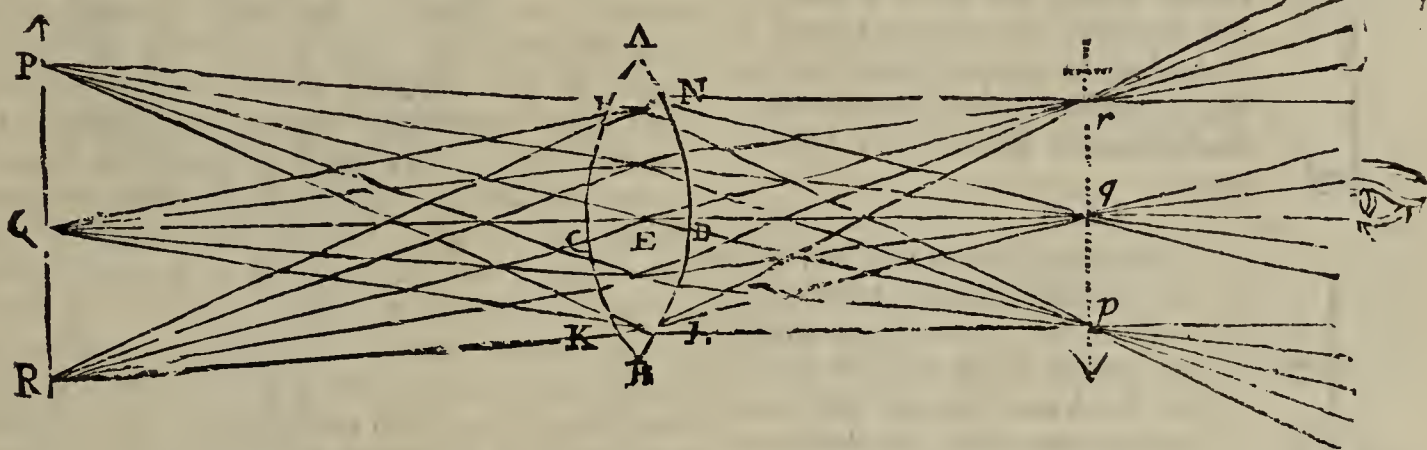
In like Manner, if there be a Prism of Glass (that is, a Glass bounded with two equal and parallel Triangular Ends, and three plane and well polished Sides, which meet in three parallel Lines running from the three Angles of the one End, to the three Angles of the other End) and if the Refraction of the Light in passing cross this Prism be desired.





Let  $ABC$  represent a Plane cutting this Prism transversely to its three Parallel Lines or Edges

there where the Light passeth through it, and let  $DE$  be the Ray incident upon the first side of the Prism  $AC$  where the Light goes into the Glass; and by putting the Proportion of the Sine of Incidence to the Sine of Refraction as 17 to 11 find  $EF$  the first refracted Ray. Then taking this Ray for the Incident Ray upon the second side of the Glass  $BC$  where Light goes out, find the next refracted Ray  $FG$  by putting the Proportion of the Sine of Incidence to the Sine of Refraction as 11 to 17. For if the Sine of Incidence out of Air into Glass be to the Sine of Refraction as 17 to 11, the Sine of Incidence out of Glass into Air must on the contrary be to the Sine of Refraction as 11 to 17, by the third Axiom.



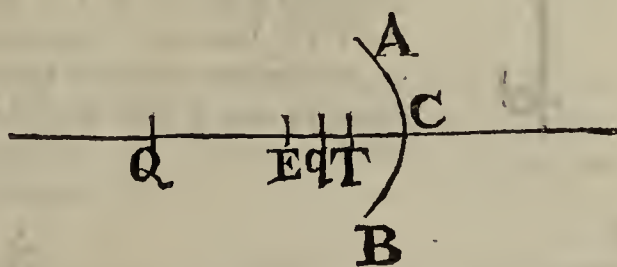
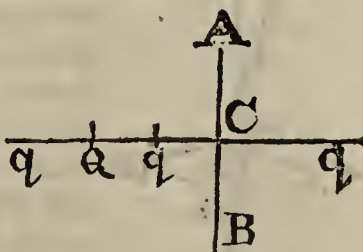
Much after the same Manner, if  $ACBD$  represent a Glass spherically convex on both Sides usually called *Lens*, such as is a Burning-Glass, or Spectacle Glass, or an Object-Glass of a Telescope) and it be required to know how Light falling upon it from any lucid Point  $Q$  shall be refracted, let  $QM$  represent a Ray falling upon any Point  $M$  of its first spherical Surface  $ACB$ , and by erecting a Perpendicular to the Glass at the Point  $M$ , find the first refracted Ray  $MN$  by the Proportion of the Sines 17 to 11, Let that Ray in going out of the Glass be incident upon  $N$ , and then find the second refracted Ray  $Nq$  by the Proportion of the Sines 11 to 17. And after the same Manner may the Refraction be found when the *Lens* is convex on one Side, and plane or concave on the other, or concave on both Sides.

#### A X. VI.

*Homogeneous Rays which flow from several Points of any Object, and fall almost perpendicularly on any reflecting or refracting Plane or Spherical Surface, shall afterwards diverge from so many other Points, or be parallel to so many other Lines, or converge to so many other Points, either accurately or without any sensible Error. And the same thing will happen, if the Rays be reflected or refracted successively by two or three or more Plane or Spherical Surfaces.*

The Point from which Rays diverge, or to which they converge, may be called their *Focus*. And the Focus of the incident Rays being given, that of the refracted or reflected ones may be found by finding the Refraction of any two Rays, as above; or more readily thus.

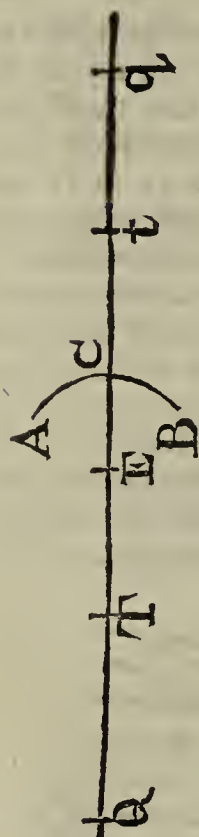
*Cas. 1.* Let  $ACB$  be a reflecting or refracting Plane, and  $Q$  the Focus of the incident Rays, and the  $Qq$   $C$  a Perpendicular to that Plane. And if this Perpendicular be produced to  $q$ , so that  $qC$  be equal  $QC$ , the Point  $q$  shall be the Focus of the reflected Rays. Or if  $qC$  be taken on the same side of the Plane with  $QC$  and in Proportion to  $QC$  as the Sine of Incidence to the Sine of Refraction, the Point  $q$  shall be the Focus of the aforesaid Rays.



*Cas. 2.* Let  $ACB$  be the reflecting Surface of any Sphere whose Center is  $E$ . Bisect any Radius thereof (suppose  $EC$ ) in  $T$ , and if in that Radius on the same side the point  $T$  you take the Points  $Q$  and  $q$ , so that  $TQ$ ,  $TE$ , and  $Tq$  be continual proportionals, and the point  $Q$  be the Focus of the incident Rays, the point  $q$  shall be the Focus of the reflected ones.

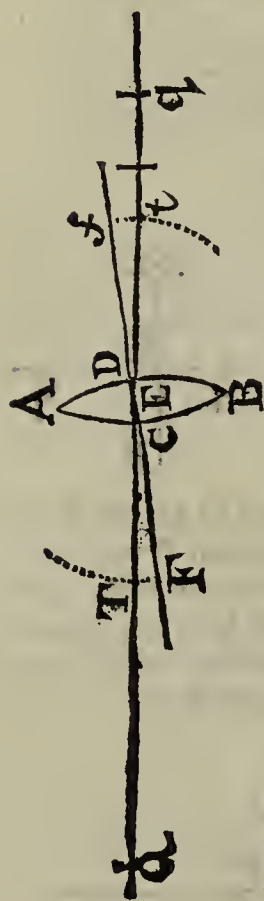
*Cas. 3.*





*Case 3.* Let  $B C B$  be the refracting Surface of any Sphere whose Center is  $E$ . In any Radius thereof  $E C$  produced both ways take  $E T$  and  $C t$  severally in such Proportion to that Radius as the lesser of the Sines of Incidence and Refraction hath to the difference of those Sines. And then if in the same Line you find any two Points  $Q$  and  $q$ , so that  $T Q$  be to  $E T$  as  $E t$  to  $t q$ , taking  $t q$  the contrary way from  $t$  which  $T Q$  lieth from  $T$ , and if the Point  $Q$  be the Focus of any incident Rays, the Point  $q$  shall be the Focus of the refracted ones.

And by the same Means the Focus of the Rays after two or more Reflexions or Refractions may be found.



*Case 4.* Let  $A C B D$  be any refracting Lens, spherically convex or concave or plane on either Side, and let  $C D$  be its Axis (that is, the Line which cuts both its Surfaces perpendicularly, and passes through the Centers of the Spheres,) and in this Axis let  $F$  and  $f$  be the Foci of the refracted Rays found as above, when the incident Rays on both sides the Lens are parallel to the same Axis; and upon the Diameter  $F f$  bisected in  $E$ , describe a Circle. Suppose now that any Point  $Q$  be the Focus of any incident Rays, draw  $Q E$  cutting the said Circle in  $T$  and  $t$ , and therein take  $t q$  in such Proportion to  $t E$  as  $t F$  or  $T E$  hath to  $T Q$ . Let  $t q$  lie the contrary way from  $t$  which  $T Q$  doth from  $T$ , and  $q$  shall be the Focus of

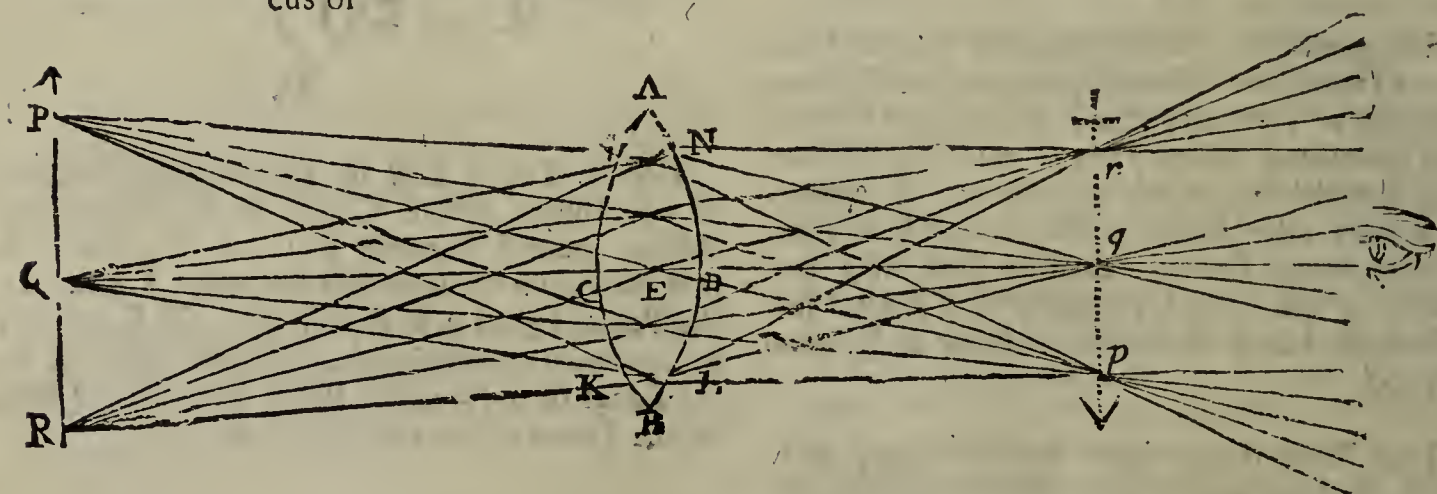
the refracted Rays without any sensible Error, provided the Point  $Q$  be not so remote from the Axis, nor the Lens so broad as to make any of the Rays fall too obliquely on the refracting Surfaces.

And by the like Operations may the reflecting or refracting Surfaces be found when the two Foci are given, and thereby a Lens be formed, which shall make the Rays flow towards or from what place you please.

So then the Meaning of this Axiom is, that if Rays fall upon any plane or spherical Surface or Lens, and before their Incidence flow from or towards any Point  $Q$  they shall after Reflection or Refraction flow from or towards the Point  $q$  found by the foregoing Rules. And if the incident Rays flow from or towards several Points  $Q$ , the reflected or refracted Rays shall flow from or towards so many other Points  $q$  found by the same Rules. Whether the reflected and refracted Rays flow from or towards the Point  $q$ , is easily known by the Situation of that Point. For if that Point be on the same side of the reflecting or refracting Surface or Lens with the Point  $Q$ , and the incident Rays flow from the Point  $Q$ , the reflected flow towards the Point  $q$  and the refracted from it; and if the incident Rays flow towards  $Q$ , the reflected flow from  $q$ , and the refracted towards it. And the contrary happens when  $q$  is on the other Side of that Surface.

#### A X. VII.

*Where-ever the Rays which come from all the Points of any Object meet again in so many Points after they have been made to converge by Reflexion or Refraction, there they will make a Picture of the Object upon any white Body on which they fall.*

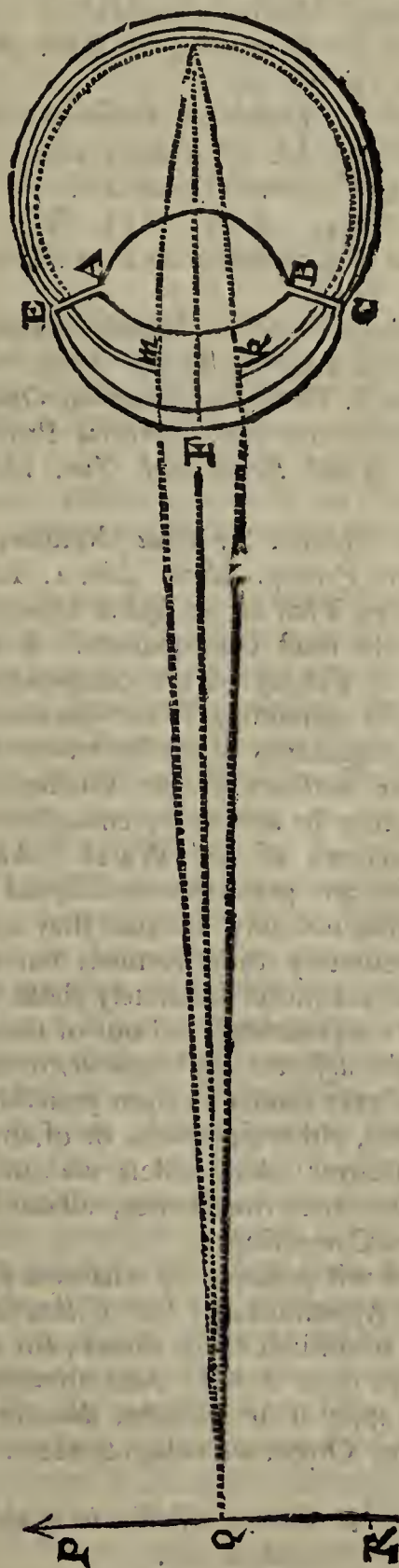


So if  $P R$  represent any Object without Doors, and  $A B$  be a Lens placed at a Hole in the Window-shut of a dark Chamber, whereby the Rays that come from any Point  $Q$  of that Object are made to converge and meet again in the Point  $q$ ; and if a Sheet of white Paper be held at  $q$  for the

Light there to fall upon it: The Picture of that Object  $P R$  will appear upon the Paper in its proper Shape and Colours. For as the Light which comes from the Point  $Q$  goes to the Point  $q$ , so the Light which comes from other Points  $P$  and  $R$  of the Object, will go to so many other correspondent



spondent Points  $p$  and  $r$  (as is manifest by the sixth Axiom;) so that every Point of the Object shall illuminate a Correspondent Point of the Picture, and thereby make a Picture like the Object in Shape and Colour, this only excepted that the Picture shall be inverted. And this is the Reason of that vulgar Experiment of casting the Species of Objects from abroad upon a Wall or Sheet of white Paper in a dark Room.



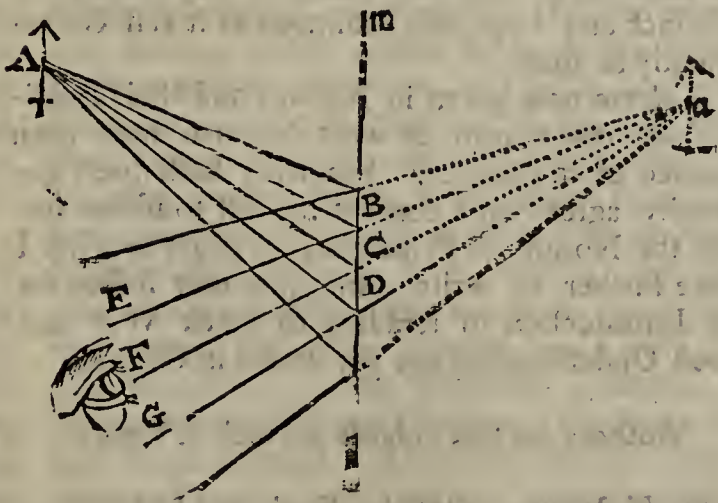
In like Manner when a Man views any Object PQR, the Light which comes from the several Points of the Object is so refracted by the transparent Skins and Humours of the Eye, (that is, by the outward Coat EFG called the *Tunica Cornea*, and by the Crystalline Humour AB which is beyond the Pupil  $m$   $k$ ) as to converge and meet again at so many Points in the Bottom of the Eye, and there to paint the Picture of the Object upon that Skin (called the *Tunica Retinæ*) with which the Bottom of the Eye is covered. For Anatomists, when they have taken off from the Bottom of the Eye that outward and most thick Coat called the *Dura Mater*, can then see through the

V O L. II.

thinner Coats the Pictures of the Objects lively painted thereon. And these Pictures propagated by Motion along the Fibres of the Optick Nerves into the Brain, are the Cause of Vision. For accordingly as these Pictures are perfect or imperfect, the Object is seen perfectly or imperfectly. If the Eye be tinged with any Colour (as in the Disease of the *Faundice*) so as to tinge the Pictures in the Bottom of the Eye with that Colour, then all Objects appear tinged with the same Colour. If the Humours of the Eye by old Age decay, so as by shrinking to make the *Cornea* and *Coat* of the *Crystalline Humour* grow flatter than before, the Light will not be refracted enough, and for Want of a sufficient Refraction will not converge to the Bottom of the Eye, but to some Place beyond it, and by Consequence paint in the Bottom of the Eye a confused Picture, and according to the Indistinctness of this Picture the Object will appear confused. This is the Reason of the Decay of Sight in old Men, and shews why their Sight is mended by Spectacles. For those Convex Glasses supply the Defect of Plumpness in the Eye, and by encreasing the Refraction, make the Rays converge sooner, so as to convene distinctly at the Bottom of the Eye, if the Glass have a due Degree of Convexity. And the contrary happens in short-sighted Men whose Eyes are too plump. For the Refraction being now too great, the Rays converge and convene in the Eyes before they come at the Bottom; and therefore the Picture made in the Bottom, and the Vision caused thereby, will not be distinct, unless the Object be brought so near the Eye, as that the Place where the converging Rays convene may be removed to the Bottom, or that the Plumpness of the Eye be taken off, and the Refractions diminished by a Concave Glass of a due Degree of Concavity; or lastly, that by Age the Eye grow flatter till it come to a due Figure: For short-sighted Men see remote Objects best in Old Age, and therefore they are accounted to have the most lasting Eyes.

#### A X. VIII.

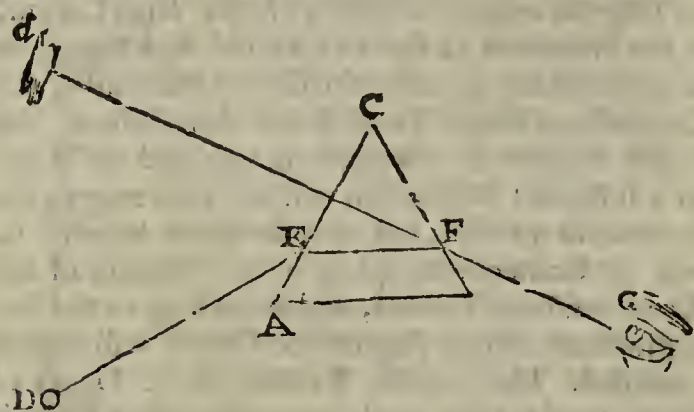
*An Object seen by Reflexion, or Refraction, appears in that Place from whence the Rays after their last Reflexion or Refraction diverge in falling on the Spectator's Eye.*



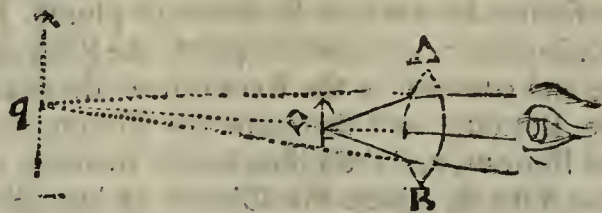
If the Object A be seen by Reflexion of a Looking-glass  $m$   $n$ , it shall appear, not in its proper Place A, but behind the Glass at  $a$ , from whence any Rays AB, AC, AD, which flow from one and the same Point of the Object, do after their



Reflexion made in the Points B, C, D, diverge in going from the Glass to E, F, G, where they are incident on the Spectator's Eyes. For these Rays do make the same Picture in the Bottom of the Eyes as if they had come from the Object really placed at *a*, without the Interposition of the Looking-glass; and all Vision is made according to the Place and Shape of that Picture.



In like Manner the Object D seen through a Prism appears not in its proper Place D, but is thence translated to some other place *d* situated in the last refracted Ray F G drawn backward from F to *d*.



And so the Object Q seen through the Lens AB, appears at the Place *q* from whence the Rays diverge in passing from the Lens to the Eye. Now it is to be noted, that the Image of the Object at *q* is so much bigger or lesser than the Object it self at Q, as the Distance of the Image at *q* from the Lens AB is bigger or less than the Distance of the Object at Q from the same Lens. And if the Object be seen through two or more such Convex or Concave Glasses, every Glass shall make a new Image, and the Object shall appear in the Place and of the Bigness of the last Image. Which Consideration unfolds the Theory of Microscopes and Telescopes. For that Theory consists in almost Nothing else but the describing such Glasses as shall make the last Image of any Object as distinct and large and luminous as it can conveniently be made.

I have now given in Axioms and their Explications the Summ of what hitherto hath been treated of in Opticks. For what hath been generally agreed on I content my self to assume under the Notion of Principles, in order to what I have further to write: And this may suffice for an Introduction to Readers of quick Wit and good Understanding not yet versed in Opticks.

Authors on this Subject are such as these;

Sir Is. Newton's *Opticks*, Engl. and Lat.

*Physico-Mathesis de Lumine, Coloribus, & Iride* per Fr. Mar. Grimaldi. Bononiæ. 1665. 4to.

*Cogitationes Physico-Mechanicæ de Natura Visionis.* per J. Ott. Schaphusam. Heidelbergh. 1670. 4to.

*Synopsis Optica per Honorat. Fabrum*, Lugduni. 1667.

*L'Occhiale all' Occhio overo Dioptrica Practica del Carlo Ant. Mancini.* Bolognæ. 1660. 4to.

*Lectiones 18 Cantabr. in Scholis Habitæ, in quibus Opticorum Phænomenon genuinæ Rationes investigantur & exponuntur.* Per D. Is. Barrow Lond. 1669. 4to.

*La Dioptrique Oculaire, par le Pere Cherubin D'Orleans.* Paris. 1671. Fol.

*A Treatise of Dioptricks, by Will. Molineux, Esq;* F. R. S. 4to.

*Catoptrica & Dioptrica Elementa.* Per D. Gregorium, M. D. Oxon, 1695. 8vo.

*Alhazeni & Vitellionis Optica.* Fol.

*Aguillonii Optica.* Antv. 1613. Fol.

*L'Optique & Catoptrique du Pere Mursennes,* à Paris. 1651.

*Christ. Scheineri Optica.* Lond. 1652.

*Jacobi Gregorii Optica.* Lond. 1663.

*Joan. Baptist. Porta de Refractione Optices.* 15.

Mr. Leibnitz his one Universal Principle of Opticks in *Act. Erud. Lips.* Jun. 1682.

**OPTICK Glasses.** Sir Isaac Newton, in his *Philos. Natur. Princip. Math. Lib. 1. Schol. ad Prop. 98*, says, That for all Optick Uses, Spherick Figures are the most commodious. If the Object-Glasses of Telescopes were composed of two Spherick Glasses containing Water between them, perhaps the Irregularity of the Refractions that are made on the Surfaces of the Glasses towards their Edges, may be accurately enough corrected by the Refractions of the Water. And such Object-Glasses are preferable to Elliptick or Hyperbolick Glasses not only because they are easier and more accurately to be formed, but also because they refract more accurately those Pencils of Rays that are (*collateral*; or) out of the Glasses Axis. But the *different Refrangibility* of different Rays will for ever hinder us from perfecting Opticks by Glasses, either Spherick, or of any other Figures whatsoever: And unless we can correct the Errors that arise from hence, all our Labour is lost in other Corrections.

Nor indeed is it possible, by whatever Figures, to render the Appearance of the *Collateral* Parts of an Object so distinct as the direct; for the very Natural Eye does it not: And therefore we are forced to apply it successively, *directly* before the Parts of any Object we design to view.

To know whether Optick-Glasses be truly Centered, or not.

#### First Way.

Holding the Glasses at a due Distance from the Eye, observe the two reflected Images of a Candle; for where those two Images unite, or coalesce, there is the true Centre of the Glass: And if this be in the middle or central Point of the Glass's Breadth, the Glass is truly centered.

#### A Second Way is

By presenting the Glass before the Sun, and making it reflect the Light on a Plane highly parallel



parallel to its Surface, and at a proper Distance; for then you'll perceive two Sorts of Light reflected, one *smaller*, but much more *strong* and *vigorous*, within another more *faint* and *large*. Then by a due Posture of the Glass (found by Trials) both these Lights are to be projected as round as possible, and at a proper Distance from the Wall on which they are reflected; the *round brightest Spot* is to be brought into the smallest Compass that it can. (Trial will make all this plain.) When the Glass is in this Posture, if the *bright Spot* be projected just in the middle of the fainter Light, the Glass is *well center'd*: But to whatever side of the *faint* Light this *bright Spot* is projected, *on that side* is the Glass *thickest*, and on that side lies the *true Centre*.

### A Third Way

*Of Examining the Centres of Glasses, is yet more Compleat than the former: For it does not only discover the Fault, (if there be any, as in long Object-Glasses 'tis very rare but there is, especially if they be wrought in the Form by the unguided Hand, and not by an Engine) but withal it rectifies the Fault; and is thus,*

Cover the Surface of the Glass within a thin Piece of Paper, in which there is cut a round Hole of about an Inch Diameter; about this Hole there are to be struck two or three Concentrick Circles. Move this Paper upon the Glass, 'till you see on the Plane that receives the reflected Light, that the *bright Spot* is exactly in the middle of the other fainter Light round it.

This also one may measure by a Pair of Compasses, having to that End, slightly fixed the Paper to the Glass, that we may more nicely determine whether this *bright Spot* be exactly in the middle. This therefore being carefully adjusted, by gently sliding the Paper on the Glass, (if it be requisite) we are, without the least altering this true Position of the Paper, to fix it more firmly to the Glass; and laying it thus on a Table, let us Mark on the Glass (by the Point of a Diamond) three Points in one of the Circumferences concentrick to the round Hole in the Paper; and sticking a small Piece of Cement on the Glass, about the middle of the round Hole, by means of the three marked Points let us find the exact Centre of this round Hole: Then uncovering the whole Glass, (except only the Cement in which the Centre is marked) with a Diamond-pointed Compass let us strike as large a Circle on the Glass as its Breadth will bear; then round the Glass according to this Circle, and 'tis as exactly *centered* as the Sense can judge.

*For trying the Regularity and Goodness of an Object-Glass, to the greatest Exactness.*

On a Paper strike two Concentrick Circles, one whose Diameter is the same with the Breadth of the Object-Glass, t'other, of half that Diameter: This inward Circumference divide into six equal Parts, by the known Way of applying the Radius six times in the Circumference, and making six fine small Holes therein with a Needle. Let us cover one side of the Glass with this Pa-

per, and then exposing it to the Sun, we are to receive the Rays that pass through these six Holes, on a Plane; at a just Distance from the Glass; and by withdrawing or approaching this Plane from or to the Glass, we shall find whether the Rays that pass through these six Holes unite exactly together at any Distance from the Glass; if they do, we may be assured of the *Regularity* of the Glass, that is, of its *just Form*; and at the same time we obtain exactly the Glass's *Focal Length*.

But, after all, there is no better way for trying the Excellency of an *Object-Glass*, than by placing it in a Tube, and trying it with small *Eye-Glasses*, at several distant Objects: For that Object-Glass that represents the Objects the *brightest* and most *distinct*, that bears the *greatest Aperture*, and most *Convex* and *Concave Eye-Glass*, without Colouring or Haziness, is surely the best. The most convenient Object to try them at, is the *Title Page* of a large Book, where there are generally Letters printed of divers Magnitudes, and therefore affording Variety of small Objects; whereby the Comparative Excellency of Object-Glasses may be nicely estimated.

*OPTICK Nerves*, or the *Nervi Visorii*, are the Second Pair, which bestow on the Eyes the Faculty of seeing: They spring from the upper Sides of those unequal Protuberances of the *Crud* of the *Medulla Oblongata*, which are called *Nervorum opticorum Thalami*; from whence being carried forward, and somewhat downwards after having fetched a Compass, they meet one another about the *Infundibulum*, upon the *Sella* of the *Os Sphenoides*; where they are united by the closest Conjunction, but not Confusion, of their Fibres, which run Parallel lengthways in these Nerves, as they do in all other.

They are obscurely hollow untill they be united; but after their Hollowness, cannot be discerned. This Hollowness may be shewed in a large Beast newly killed, and in a clear Light.

Thus do *Riolanus*, *Glisson*, &c. teach; but *Vesalius*, *Aquapendente*, &c. deny they have any manner of Cavity. *Malpighius* says, they have not one Cavity only, but sundry; but that these Cavities Result only from the Necessity of their Structure, all their inner or medullar Part consisting of round *Intestinula* or Fibres running lengthways, which cannot be so closely fitted to one another, but that there will result long Interstices, which yet perhaps are of no use, nor of the Nature of Ducts, but only accidental; but whether the *Intestinula*, or Filaments themselves, have not little Channels in them (like to Blood-Vessels) he thinks may be doubted of: But seeing Sense hath not discovered any such, 'tis probable that there are to be admitted only little Pores and Interstices in the medullar Substance, by means whereof the nourishing and vivifying Juice may be propagated. After their Union they are separated again, and each of them running farther forwards, passes thro' a Hole of the *Os Cuneiforme*, and is inserted obliquely into the Centre of the Eye on its own side.

Dr. *Willis* says, they receive not only nervous Fibres from the third Pair of Nerves, but also

Twigs



Twigs of Arteries from the fore Branches of the *Carotides*, which run upon them as far as the *Basis* of the Eye: Whence he thinks a Reason may be assigned, why, when a Man grows sleepy after plentiful eating or drinking, he presently feels a notable Heaviness or Oppression as it were about his Eyes. For when the Blood becoming very turgid, fills the Vessels that run through the Brain, more than usual, and by distending them, stops the Pores of the Brain; these Nerves also in their whole Course are compressed by the Blood that is become turgid in their Blood-Vessels likewise.

Dr. Ridley says, That he has seen the Blood-Vessels to run not only upon or within them, but also in injected Bodies exactly quite thro' the medullary Substance of them, into the Reticular Coat of the Eye, wherein they end in an infinite Number of the most capillary Ramifications, which by an Injection of that Artery, made with Mercury becomes very delightfully conspicuous to the Eye.

They are very soft, so long as they are within the Skull; but having pass'd the *Os Sphænoides*, they become somewhat more firm and hard. The Reason of which Alteration seems to be, that within the Skull they are only clad with the *Pia mater*; but as they go out they assume a Second Coat from the *Dura mater*.

From the whole Substance of these Nerves, viz. from their two Membranes and the inner medullar and fibrous Substance, are the three proper for Tunics of the Eyes framed; the *Cornea* or *Sclerotica* doth proceed from the *Dura mater*, the *Choroides* or *Uvea* from the *pia mater*, and the *Retina* from the marrowy Substance.

OPTICK Place of a Star or Planet, is that Point or Part of its Orbit which is determined by our Sight when the Star is there: And this is either *True*, when the Observer's Eye is supposed to be at the Centre of the Earth or Planet he inhabits; or *Apparent*, when his Eye is at the Circumference of the Earth: And the Difference between these two is the *Parallax*, whose Use is great in determining the Distances of the Planets, &c.

OPTION; when a new Suffragan Bishop is consecrated, the Archbishop of the Province, by a customary Prerogative, claims the Collation of the first vacant Benefice, or Dignity in that See, according as he shall choose; which Choice is therefore called the *Archbishop's Option*.



OR, (*French*) in Heraldry, is the Colour of Gold; and they say without this, or *Argent*, there can be no good Armoury. In the Coats of Nobles 'tis called *Topaz*, and in those of Sovereign Princes, *Sol*. 'Tis represented in Engraving by small Points or Pricks, thus,

ORA or Ore, in the Time of the Saxons, according to Sir H. Spelman, signified an Ounce, and he saith, that it was also a Piece of Money, in Value 16 Pence; and the judicious Author of the *Chronicon Pretiosum*, concludes that when we find Mention made of 12 Oræ in a Pound, then the *Ora* is 20 pence; and whenever there is said to be 15 Oræ in a Pound, then the *Ora* is 16 pence, in which he agrees with Mr. Somner.

ORANDO *pro Rege & Regno*; was a Writ formerly (before there was any Collect purposely appointed,) requiring the Bishops and Clergy, to pray for the Peace and good Government of the Realm, and for a good Understanding between the King and his Parliament.

ORB, is only a Hollow Sphere.

ORBICULAR Bone, is one of the little Bones of the inward Ear, tyed by a slender Ligament to the sides of the *Stapes*.

ORBICULARIS, or *Constringens*, or *Osculatorius*, is a Muscle that draws both Lips together: 'Tis called also *Sphincter Labiorum*.

ORBICULARIS Palpebrarum, is a thin fleshy Muscle, whose Fibres do Circularly environ the Eye-Lids, and are inserted to them, (like the *Sphincter Labiorum*) not adhering to any Bone, from whence we may derive their Origin, except the Superior Part of the great Bone of the Nose, by some reckoning the fourth Bone of the upper Jaw: This Muscle acting like the Sphincters of all other Parts, constringes the Eye-lids.

ORBIS Magnus is the Orbit of the Earth in its Annual Revolution round the Sun.

This *Copernicus*, Dr. Gregory, and some others, will have to be but a Point in Comparison of the Distance betwixt us and the fixed Stars: But our most accurate Astronomer, Mr. Flamsteed, found a very sensible Parallax of this *Orbis Magnus*, in respect of the Pole Star; so that the Pole Star was nearer to the Pole in Summer (at the Solstice) than in Winter by 40 or 45"; and this was the Result of above seven Years most accurate and continual Observation. And from hence he justly draws a *Demonstration* for the Annual Motion of the Earth. Vide *Wallis Latin Works*, Tom. 3.

The Semi-diameter of this Annual Orbit of the Earth round the Sun, Dr. Gregory makes to be 500000000000, or Fifty Thousand Millions of Feet; which is (allowing 5280 Feet to a Mile) 94.696969 Miles *Englsh*. Which therefore may be taken for the mean Distance of the Earth from the Sun. And the Semi-diameter of *Saturn's* Orbit, is about 10 times as great.

All the Ancients and the Astronomers before the Great *Kepler* supposed this Orbit to be a perfect Circle, but he proves it to be an Ellipsis; the remotest End of whose Longer or Transverse Diameter is eight Signs and eight Degrees distant from the first Star in *Aries*, and having the Sun in one of its Focal Points.

ORBIT of any Planet, is the Curve that it describes in its Revolution round its Central Body: Thus the Orbit of the Sun (or of the Earth) in its Annual Course, is the *Ecliptick*.

ORBIT, The Orbits of the Planets are not all in the same Plane with the *Ecliptick* of the Earth's Orbit round the Sun; but variously inclined to it and to one another at different Angles: But the Plane of the *Ecliptick* intersects the Plane of the Orbit of every Planet in a Right Line, which passes thro' the Sun. The Quantities of the Inclinations of the Planes of the Orbits of the Primary Planets to that of the *Ecliptick* are as follow. That of *Saturn* is an Angle of 2 Degr.  $\frac{1}{2}$ . That of *Jupiter* is an Angle of 1 Degr. 20 Min. That of *Mars* is almost 2 Degr. *Venus* is a little more than 3 Degr. 20'. And that of *Mercury* is a little more than 7 Degr.



**ORBITER Externus**, is a Hole in the *Os Maxillare*, below the Orbit, thro' which the Nerves and Vessels which come from the Teeth, pass to the Cheeks.

**ORBITER Internus**, is a Hole in the *Coronal Bone*, within the Orbit, a little above the *Os Planum*, thro' which passes a Branch of the fifth pair of Nerves which goes to the Nose.

**ORDEAL**, was the old Judicial Custom of proving the Guilt, or attesting the Innocence of Parties accused; chiefly by *Water* or *Hot Iron*. This *Ordeal* was simply call'd *Judicium*, in Opposition to *Bellum*, which was Duel or Combat Fight, the other customary Purgation. Neither of these Trials were taken away by *William the Conquerour*, as Sir *W. Temple* asserts. *Ordeal* might be undergone by Servants or Deputies in the Cause and Name of their Masters; especially of those Lords who were Bishops and Ecclesiastical Men. Dr. *Kennett's Glossary at the End of his Parochial Antiquities*.

**ORDER** is a Term in *Military Discipline*, being the equal Distance of one *Rank* or *File* from another. The usual *Order* in *Files* is 3 Foot, and in *Ranks* 6 Foot; the *Open Order* is double in each.

**ORDER** in *Architecture*, is a Rule for the Proportion to be observed in the erecting of Pillars, and for the form of certain parts appertaining to them.

So Buildings are said to be of several *Orders*, when the Proportion between the Thickness of the Columns, and their Height, together with all things requisite thereto are different.

There are five Principal Orders of Architecture, viz. The *Tuscan*, *Dorick*, *Ionick*, *Corinthian*, and the *Composit*.

The *Tuscan* is the most simple, and the most destitute of Ornaments, so that it is seldom used except in Vaults, in some Rustick Edifices, vast Piles of Buildings, as *Amphitheatres*, &c.

The *Tuscan* Pillar with its base and Capital generally hath for its height seven Diameters of its thickness taken below, and the Top ought to be diminished one Quarter of its Diameter: The Pedestal is very plain, and only one Model high.

The *Dorick Order*, hath its Column eight Diameters high, and ought to have no Ornament neither in its Capital nor Base. The *Astragal* and *Lisfel* below the Capital, which is half a Diameter high, constituting Part of the Shank or Body of this Pillar.

The *Ionick Order*, when first invented had its Column only eight Models high; but the Ancients designing to make it more beautiful, augmented the Height of the Pillars, and added a Base not used before; so that with its Capital and Base it contains nine Diameters of its thickness taken below: The Pedestal is two Diameters, and about two thirds high; and the Capital is chiefly composed of *Voluta's* or Scrolls, which render it different from the other Orders: The *Ionick* Pillars are also usually channelled with 24 Flutes.

The *Corinthian Order* is the finest and richest of all; the Length of its Columns with their Ba-

ses and Capitals, is commonly about nine and a half or ten Diameters; and the Capitals are adorned with two Rows of Leaves, and eight *Voluta's* that support the *Abacus*.

The *Composit* or *Roman Order*, hath the Capital of its Pillar composed of two Rows of Leaves like the *Corinthian*, and of the *Voluta's* or Scrolls of the *Ionick*. These Columns are usually ten Diameters high, altogether like the *Corinthian* in all its Dimensions and Numbers, except the Capital, which hath only four *Voluta's* taking up the whole Space, which is filled both by the *Voluta's* and Stems or Stalks in the *Corinthian*.

To these Five Orders may be added also

The *Attick*, which is a small Order of *Pilasters* of the shortest Proportion, having a Cornice raised after the manner of an *Architrave*, for its Entablature. As also

The *Gothick Order*, which is so far from the ancient Proportions and Ornaments, that its Columns are either too massie in Form of vast Pillars, or as slender as Poles, having Capitals without any certain Dimensions, carved with the Thorny Leaves of *Thistles*, *Coleworts*, *Bears-foot*.

**ORDINANCE** of *Parliament*, the same with *Acts of Parliament*: And Acts of Parliaments are in the Parliament-Rolls often called *Ordinances of Parliament*. If there be any Difference, it is, that an *Ordinance* is but Temporary, and to be alter'd by Commons alone; but an *Act* is a perpetual Law, and cannot be alter'd but by King, Lords, and Commons. But Sir *Edw. Coke* asserts, That an *Ordinance of Parliament* is to be distinguished from an *Act*, for as much as the latter can be only made by the King and the threefold Consent of the Estates, whereas the former is ordained with or by two of them.

**ORDINANCE** of the *Forest*, is a Statute made about Forest Causes in the Thirty Fourth Year of *Edw. I.* See *Affize*.

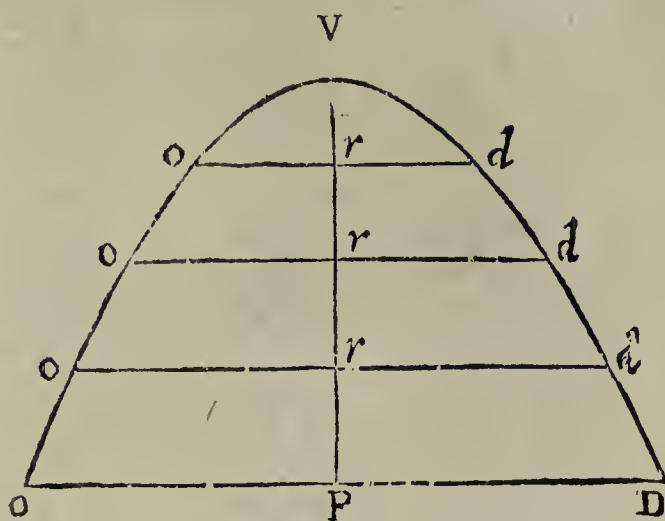
**ORDINARY**, in the Civil Law signifies any Judge that hath Authority to take Cognizance of Causes in his own Right, as he is a Magistrate, and not by Deputation; but in the Common Law, it is taken for him that hath exempt and immediate Jurisdiction in Causes Ecclesiastical.

**ORDINARIES**, in Heraldry, are such Charges as are proper to the Art and Usage of Armory; and therefore are commonly called the Honourable Ordinaries; and are the *Cross*, the *Chef*, the *Pale*, the *Bend*, the *Fesse*, the *Escutcheon*, the *Chevron*, the *Saltier*, and the *Bar*.

**ORDINATE** Figures (in Geometry) are the same with Regular ones; that is, they are *Equilateral* and *Equiangular*.

**ORDINATE**, or *Ordinate Applicate*, is a Line in any Conick Section drawn at Right Angles to and bisected by the Axis, and reaching from one side of the Section to the other; the half of which is properly the Semi-ordinate, but is now usually called the Ordinate.





Thus, in the Parabola OVD, OD, or  $o d$ , is an Ordinate rightly applied, and its half  $r d$ , or RD, is the true Semi-Ordinate, tho' usually called the Ordinate it self.

The Properties of these Lines you will find under the several *Conick Sections*.

Dr. Wallis in his *Conick Sections*, calls the whole Ordinates OD, &c. the *Lineæ ordinatim inscriptæ*, and the Semi-ordinates OR, &c. he calls the *Ordinate Applicatæ*.

ORDINATIONE *contra servientes*, is a Writ that lieth against a Servant for leaving his Master.

ORDNANCE, all Sort of Great Guns used in War. The several Parts of a Piece of Ordnance, or Great Gun are thus called.

1. The Outside round about the Piece, is called the *Superficies of her Metal*.

2. The Substance or whole Mass of Metal, is called her *Body*.

3. The Part next to us when she stands ready to fire, is called the *Breech* or *Coyle*, and the Pummel or round Knob at the End of it, is called the *Cascabell*; by some the *Cascabell Dock*.

4. The *Trunnions* are the two Knobs, Spindles, or Ears, which hold the Piece in the Carriage.

5. *Maniglions*, or *Dolphins*, after the German way of casting Guns, are two Handles placed on the back of the Piece near the *Trunnions*, and near the Centre of Gravity, to mount and dismount it the more easily.

6. The *Rings* about it are these four: The *Base Ring* is that which is next below the Touch-hole: The next Ring above the Touch-hole is called the *Reinforced Ring*: The next to that forward the *Trunnion-Ring*: The next to that the *Cornice-Ring*: And that at the Mouth is called the *Muzzle Ring*, or the *Freeze*: Also all the Rings near the Mouth are sometimes called the *Freezes*.

7. As to the Internal Parts the whole Cavity or *Bore* of the Piece is called her *Chase*. That Part of the Cavity between the *Trunnions*, and the *Muzzle* or Mouth, is called the *Vacant Cylinder*: The Part from the *Trunnions* to the End of the Cavity, or so much of it as containeth (or is Loaded with) the Powder and Shot, is called the *Chamber*. The Diameter of the Mouth is called the *Calibre*. The Space between the Shot and the Hollow Superficies of the Piece within is called the *Vent*; being the Difference between the Diameter of the Shot, and of the Mouth of the Piece.

Great Guns in England are distinguished into two Kinds only, *viz.* *Field-Pieces*, which are from the least Sort of all, to 12 Pounders (*i. e.*) those which carry a Ball or Shot of 12 Pound; and *Cannon of Battery*, which are from a *Culverin* to a whole Cannon.

The Table following gives you all things necessary to be known of the Names, Proportions, Weights, Lengths, Bullets, Ranges, &c. of a Great Gun.

P H I L L I P S's T A B L E.

The Names of the several Pieces of Ordnance.	Guns Length.	Guns Weight.	Guns Bore.	Bullets Diameter.	Bullets Weight.	Ladles Length.	Ladles Breadth.	Weight of Powder.	Point-Blank, or the Level-Range.	Utmost Ranges.
	Feet.	Pounds.	8 Parts Inches.	8 Parts Inches.	Pounds.	8 Parts Inches.	8 Parts Inches.	Pounds.	Paces.	Paces.
A Base	4 6	200	1 2	1 1	0 5	4 0	2 0	0 8	60	600
A Rabinet	5 6	300	1 4	1 3	0 8	4 1	2 4	0 12	70	700
A Falconet	6 0	400	2 2	2 2	1 5	7 4	4 0	1 4	90	900
A Falcon	7 0	750	2 6	2 5	2 8	8 2	4 4	2 4	130	1300
A Minion Ordinary	7 0	800	3 0	2 7	3 4	8 4	5 0	2 8	120	1200
A Minion largest	8 0	1000	3 2	3 0	3 12	9 0	5 0	3 4	125	1250
Saker Least	8 0	1400	3 4	3 2	4 12	9 6	6 4	3 6	150	1500
Saker Ordinary	9 0	1500	3 6	3 4	6 0	10 4	6 6	4 0	160	1600
Saker Old Sort	10 0	1800	4 0	3 6	7 5	11 0	7 2	5 0	163	1630
Demiculverin Least	10 0	2000	4 2	4 0	9 0	12 0	8 0	6 4	174	1740
Demiculv. Ordinary	11 0	2700	4 4	4 2	10 11	12 6	8 0	7 4	175	1750
Demiculv. Old Sort	11 0	3000	4 6	4 4	12 11	13 4	8 4	8 8	178	1780
Culverin Least	11 0	4000	5 0	4 6	15 0	14 2	9 0	10 0	180	1800
Culverin Ordinary	12 0	4500	5 2	5 0	17 5	16 0	9 4	11 6	181	1810
Culverin Largest	12 0	4800	5 4	5 2	20 0	16 0	10 0	11 8	183	1830
Demi-Cann. Least	11 0	5400	6 2	6 0	30 0	20 0	11 4	14 0	156	1560
Demi-Cann. Ordin.	12 0	5600	6 4	6 1	32 0	22 0	12 0	17 8	162	1620
Demi-Can. Large	12 0	6000	6 6	6 3	36 0	22 6	12 0	18 0	180	1800
Royal Whole Can.	12 0	8000	8 0	7 4	58 0	24 0	14 6	32 8	185	1850



To this Table I thought it necessary to adjoin Mr. *Anderson's*; which, I question not, is *much truer*: As being the Result of more Experience, and more Skill in this kind of Mathematical Learning. However, the Differences of the Ranges are so great, that it is worth examining which is the truest.

Mr. *Anderson's* TABLE of the Names, Diameters, Chases, Requisites of Powder, Comparative Forces, and greatest Ranges, to eight Degrees of Elevation, of Ten several Pieces of Cannon, Experimentally and Mathematically demonstrated.

Names of the Pieces.	Length of the Chase.	Diamet. of the Bore.		Requi- site of Powder.		Grea- test Range.	Compa- rative Force.
	Feet.	Inches.		lb.	3.	Paces.	
1 A <i>Rabbinet</i> ————	3	1	75		5	3769	38
2 A <i>Falconet</i> ————	4	2			9	4398	61
3 A <i>Falcon</i> ————	6	2	75	1	10	4797	161
4 A <i>Minion</i> ————	8	3		2	10	5864	238
5 A <i>Saker</i> ————	9	3	5	4		5654	371
6 A <i>Demi-Culverin</i> ————	10	4		7	5	4886	733
7 A <i>Culverin</i> ————	11	5		10		4837	1000
8 A <i>Demi-Cannon</i> ————	11	6		14	6	4031	1575
9 A <i>Whole Cannon</i> ————	12	7		21	5	3769	2422
10 A <i>Cannon-Royal</i> ————	12	8		27	14	3298	3382

The Strength and Serviceableness of a Piece of Ordnance, consists very much in the Thickness of the Metal, especially about its *Chamber* and *Breech*, and this is called its *Fortification*.

And of this there are three Degrees both for Cannons and Culverines.

1. Such as are ordinarily fortified, are called *Legitimate Pieces*.

2. Those whose Fortification is lessened, are called *Bastard Pieces*.

3. There are some that are doubly fortified, which are called *Double-fortified*, or *Extraordinary Pieces*.

The Fortification of a Gun is reckoned from the Thickness of the Metal at the Touch-hole, at the Trunnions and at the Muzzle, in Proportion to the Diameter of the Bore.

The *Doubly-fortified Pieces*, are a full Diameter of the Bore in Thickness at the Touch-hole,  $\frac{1}{12}$  of it at the Trunnions,  $\frac{1}{12}$  at their Muzzle.

The *Lessened Cannons* have but  $\frac{3}{4}$  or  $\frac{7}{8}$  of the Diameter of their Bore, in Thickness at the Touch-hole,  $\frac{1}{12}$  at the Trunnions,  $\frac{1}{12}$  at the Muzzle.

All the *Double-fortified Culverines*, and all lesser Pieces of that Kind, have a Diameter and  $\frac{1}{8}$  at the Touch-hole,  $\frac{1}{12}$  at the Trunnions, and  $\frac{1}{12}$  at the Muzzle. And the Ordinary fortified Culverines are every way as your double-fortified Cannon; and the lessened Culverines are as the Ordinary Cannons in all respects.

The *Ordinary-fortified Cannons* have  $\frac{7}{8}$  at the Touch-hole,  $\frac{5}{8}$  at the Trunnions, and  $\frac{3}{4}$  at the Muzzle.

The famous *Galilæus* was the first who proved the Line of a Bullet to be in the Curve of a Parabola (*abstracting from the Line of Impulse, and the Resistance of the Medium*, as I judge) as you may find in his Fourth Dialogue; where also he gives a Table of *Horizontal Ranges*. *Discorsi e Dimostrazioni Matematiche*, p. 280, 281.

And his Scholar *Torricellius*, in his School Book

*de motu Projectorum*, brings the *Horizontal Ranges* to the Table of Sines, and the greatest Altitudes to the Versed Sines: That is, he proves, *That all Ranges on the Plane of the Horizon, are in Proportion to one another, as the Sines of the Double Angles of the Elevation of their Lines of Direction*. And for the Time of the Continuance of any Shot above the *Horizon*, he shews in *Prop. 18. Book 2*. That as Radius is to the greatest Duration (*i. e.* when the Elevation of the Piece is 90 Degrees, or when it stands Perpendicular): so is the Sine of any other Elevation of the Gun, to the Time of the Range of that Shot.

After this, one *Robert Anderson*, by Trade a Weaver, but peculiarly skilful both in the Application of Mathematicks to this Matter, and also prodigiously industrious and accurate in making Trials with both Guns and Mortars, which he procured to be cast and fitted at his own Charge: This Man, I say, in the Year 1674. published a *Book of the genuine Use and Effects of the Gun*, together with Tables of the Altitudes of Projections above the *Horizon*, &c. calculated by Mr. *Street*; in which, in fifty *Propositions*, he shews:

1. How from any Shot of a Great Gun, or any Piece howsoever made, to find the greatest Random of that Piece: And also to strike any Place upon either Ascents or Descents within the Reach of the Piece.

2. He shews the Relations of all Guns of the same Kind among themselves; and thence the Dimensions and requisite Powder of any Piece with a Range answerable to any Degree being given: He gives Rules to find the requisite Powder of any other Piece, and to strike any Place at demand within Reach, its Dimensions being also given.

3. He shews the Nature, Use and Property of Mortar-pieces, with their Complications and Relations.

4. He



4. He considers the Method of shooting Grenadoes out of Long Guns, with their manifold Uses, &c.

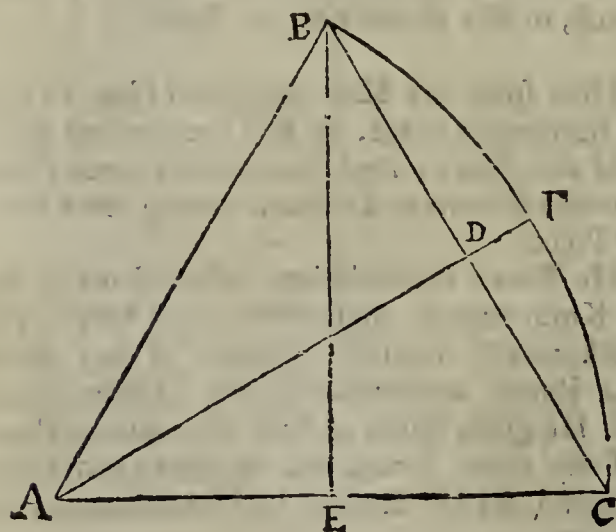
And now, very lately, that excellent Workman Mr. *John Rawley*, Mathematical Instrument-maker under St. *Dunstan's* Church in *Fleet-street*, hath contrived a Method of putting *Anderson's* Tables upon a Scale; where knowing only the utmost Random of any Gun, you have by Inspection the upper and lower Elevations that are necessary to throw the Shot to any assigned Distance within the Reach of the Piece, and *vice versa*.

In the Year 1690, *Anderson* published another Book, intituled, *To hit a Mark as well upon Ascents and Descents, as upon the Plane of the Horizon*: And in the Preface, he takes Notice of what Mr. *Blondell*, *Mariotte*, *Perault*, and *Halley* have done in this Matter; and agrees with *Cavellerius*, to begin to account the Curve of the Shot to be a Parabola, just then where the Force leaves the Thing projected; and the Line of Shot to that place, he calls, *The Line of Impulse of the Fire*, and for Ease of Calculation, takes it for a Right Line: Only he says, That the more irregular the Figure of the projected Body is, the longer the Line will be before it passes into its Parabola.

He saith, after 15 Years Experience (in which time he made some Thousands of Shots) he knows how to find the Line of Impulse of Fire, and how to carry the Matter on, on the Principles of *Galilæus*, and can hit a Mark not only on the Plane of the *Horizon*, but upon Ascents and Descents, according to Mathematical Principles; the Method of which you have in his Book.

*The Learned Mr. Halley*, now Savilian Professor of Geometry in Oxon, in Philosophical Transactions, N°. 179. having proved the Motion of all Projectiles, to be in the Curve of a Parabola, (which you will find under Projectile) premises this Lemma.

That the Sine of the double of any Arch, is equal to twice the Sine of that Arch into its Co-sine, divided by Radius; and the versed Sine of the Double of any Arch is equal to the Square of the Sine thereof, divided by Radius.

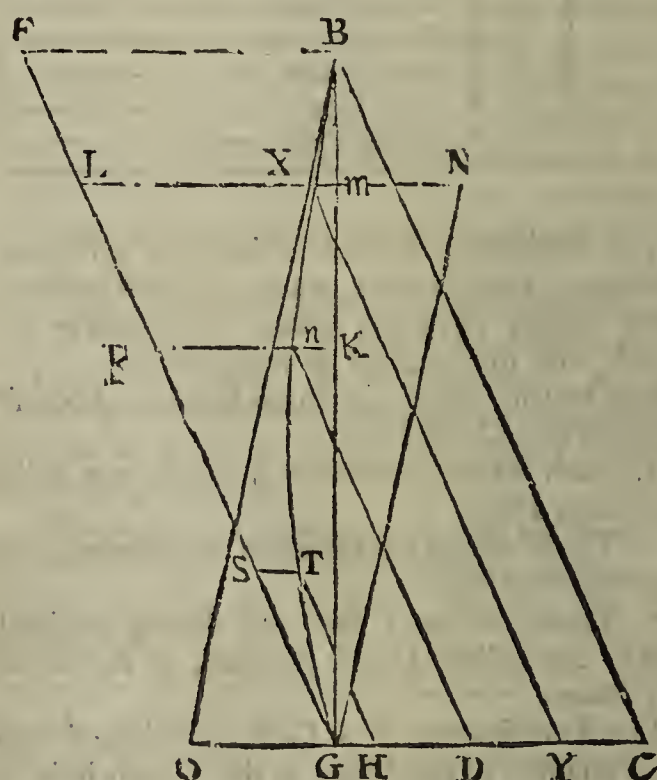


Let the Arch *B C* (in *Fig. 1.*) be double to the Arch *B F*, and *A* the Centre: Draw the Radii, *AB*, *AF*, *AC*, and the Chord *BDC*, and let

fall *B E* perpendicular to *AC*, and the Angle *BCE* will be equal to the Angle *ABD*, and the Triangle *BCE* will be like to the Triangle *BDA*: Wherefore it will be as *AB* to *AD*, so *BC*, or twice *BD*, to *BE*, that is as Radius to Co-sine, so twice Sine to Sine of the Double Arch. And as *AB* to *BD*, so twice *BD* or *BC* to *EC*, that is, as Radius to Sine, so twice that Sine to the Versed Sine of the Double Arch; which two Analogies resolved into Equations, are the Propositions contained in the Lemma to be proved.

### PROPOSITION I.

*The Horizontal Distances of Projections made with the same Velocity at several Elevations of the Line of Direction, are as the Sines of the double Angles of Elevation.*



Let *GB* (*Fig. 2*) the Horizontal Distance, be  $=Z$ , the Sine of the Angle of Elevation, *FGB*,  $b=s$ , its Co-sine  $=c$ , Radius  $=r$ , and the Parameter  $=p$ , it will be as  $c$  to  $s ::$  so  $z$  to  $\frac{sz}{c} = FB = GC$ , and by Reason of the Parabola  $\frac{psz}{c} =$  to the Square of *CB*, or *GF*:

Now as  $c$  to  $r ::$  so is  $z$  to  $\frac{zr}{c} = GF$ , and its Square  $\frac{zr}{c}$  will be therefore  $=$  to  $\frac{psz}{c}$

Which Equation reduced will be  $\frac{psc}{rr} = Z$ .

But by the former Lemma  $\frac{zsc}{r}$  is equal to the Sine of the Double Angle, whereof *S* is the Sine: Wherefore 'twill be as Radius to Sine of double the Angle *FGB*, so is half the Parameter, to the Horizontal Range or Distance sought; and at the several Elevations, the Ranges are as the Sines of the double Angles of Elevation. *Q. E. D.*



## C O R O L L A R Y.

Hence it follows, That half the Parameter is the greatest Random, and that happens at an Elevation of 45 Degrees, the Sine of whose double is Radius: Likewise that the Ranges equally distant above and below 45 are equal, as are the Sines of all double Arches to the Sines of their double Complements.

## P R O P. II.

The Altitudes of Projections made with the same Velocity, at several Elevations, are as the Versed Sines of the double Angles of Elevations.

As  $e$  is to  $s$  :: so is  $\frac{p s s}{r r} = G B$  to  $\frac{p s s}{r r} = B F$ , and  $U K = R U = \frac{B F}{4}$  the Altitude of the Projection  $= \frac{p s s}{4 r r}$ . Now by the foregoing Lemma  $\frac{2 s s}{r} =$  to the Versed Sine of the double Angle, and therefore it will be as Radius to Versed Sine of double the Angle  $F G B$ , so an 8th of the Parameter to the Height of the Projection  $U K$ ; and so these Heights at several Elevations, are as the said Versed Sines, Q. E. D.

## C O R O L L A R Y.

From hence it is plain, that the greatest Altitude of the Perpendicular Projection is a 4th of a Parameter, or half the greatest Horizontal Range; the Versed Sign of 180 Degrees being  $= 2 r$ .

## P R O P. III.

The Lines  $G F$ , or Times of the Flight of a Project cast with the same Degree of Velocity at different Elevations, are as the Sines of the Elevations.

As  $c$  is to  $r$  :: so is  $\frac{p s c}{r r} = G B$  by the 6th Proposition to  $\frac{p s}{r} = G F$ ; that is, as Radius to Sine of Elevation, so the Parameter to the Line  $G F$ ; so the Lines  $G F$  are as the Sines of Elevation, and the Times are proportional to those Lines: Wherefore the Times are as the Sines of the Elevation: Ergo constat Propositio.

## P R O P. IV.

Problem. A Projection being made as you please, having the Distance and Altitude, or Descent of an Object through which the Project passes, together with the Angle of Elevation, with the Line of Direction; to find the Parameter and Velocity that is (in Fig. 2.) having the Angle  $F G B$ ;  $G M$ , and  $M X$ .

V O L. II.

## S O L U T I O N.

As Radius to Secant of  $F G B$ , so  $G M$  the Distance given to  $G L$ ; and as Radius to Tangent of  $F G B$ , so  $G M$  to  $L M$ . Then  $L M = M X$  in Heights,  $+ M X$  in Descents; or else  $M X = M L$ , if the Direction be below the Horizontal Line, is the Fall in the Time that the direct Impulse given in  $G$ , would have carried the Project from  $G$  to  $L = L X = G Y$ . Then by Reason of the Parabola, as  $L X$  or  $G Y$  is to  $G L$  or  $Y X$  :: so is  $G L$  to the Parameter sought.

To find the Velocity of the Impulse, by Prop. 2. and 4. find the Time in Seconds that a Body would fall the Space  $L X$ , and by that dividing the Line  $G L$ , the Quote will be the Velocity, or Space moved in a Second sought, which is always a mean Proportional between the Parameter, and 16 Feet 1 Inch.

## P R O P. V.

Problem 2. Having the Parameter, Horizontal Distance, and Height or Descent of an Object, to find the Elevations of the Line of Directions necessary to hit the given Object; that is, having  $G M$ ,  $M X$ , and the greatest Random equal to half the Parameter; to find the Angles  $F G B$ .

Let the Tangent of the Angle sought be  $= t$ , the Horizontal Distance  $G M = b$ , the Altitude of the Object  $M X = h$ , the Parameter  $= p$ , and Radius  $= r$ , and it will be as  $r$  to  $t$ , so  $b$  to  $\frac{t b}{r} = M L$ , and  $\frac{t b}{r} + h$  { in Ascents  
in Descents  
 $= L X$ , and  $\frac{p t b}{r} + p h = G L \square = + Y \square$   
by Reason of the Parab. but  $b b + \frac{t t b b}{r r} = G L$

$\square$ . 47. 1 Euclid. Wherefore  $\frac{p t b}{r} + p h = b b + \frac{t t b b}{r r}$  which Equation transposed, is  $\frac{t t b b}{r} = \frac{p t b}{r} + p h - b b$ , divided by  $b b$ , is  $\frac{t t}{r r} = \frac{p t}{b r} + \frac{p h}{b b} - 1$ . This Equation shews the Question to have two Answers, and the Roots thereof are  $\frac{t}{r} = \frac{p}{2 b} \pm \sqrt{\frac{p p + 4 p h}{4 b b}} = 1$ . From which I derive the following Rule.

Divide half the Parameter by the Horizontal Distance, and keep the Quote, viz.  $\frac{p}{2 b}$ , then say,

As Square of the Distance given to the half Parameter, so half Parameter  $\pm$  double { Height  
Descent

to the Square of the Secant  $= \frac{p p \pm 4 p h}{4 b b}$

The Tangent answering to that Secant, will be  $\sqrt{\frac{p p \pm 4 p h}{4 b b}} - 1$  or  $r r$  :: So then the Sum



and Difference of the aforesaid Quote, and this Tangent will be the Roots of the Equation, and the Tangents of the Elevations sought.

Note here, that in Descents, if the Tangent exceed the Quote, as it does when  $p b$  is more than  $b b$ , the Direction of the lower Elevation will be below the Horizon, and if  $p b = b b$ , it must be directed Horizontal, and the Tangent of the upper Elevation will be  $\frac{p r}{b}$ : Note

likewise, That if  $4 b b + 4 p b$  in Ascents, or  $4 b b - 4 p b$  in Descents, be equal to  $p p$ , there is but one Elevation that can hit the Object, and its Tangent is  $\frac{p r}{2 b}$ ; and if  $4 b b + 4 p b$  in A-

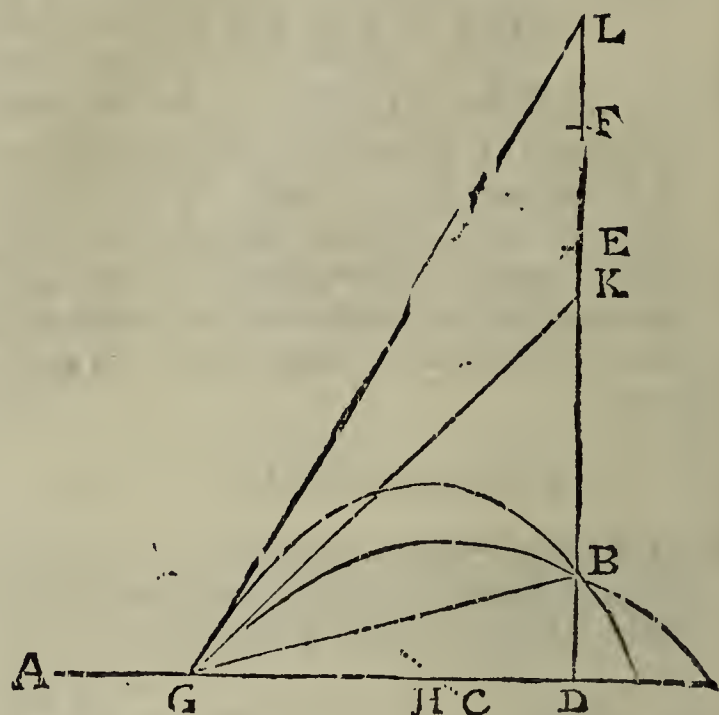
scents, and  $4 b b - 4 p b$  in Descents, do exceed  $p p$ , the Object is without the Reach of a Project cast with that Velocity, and so the Thing impossible.

From this Equation  $4 b b + 4 p b = p p$  are determined the utmost Limits of the Reach of any Project, and the Figure assigned, wherein are all the Heights upon each Horizontal Distance, beyond which it cannot pass; for by Reduction of that Equation,  $b$  will be found equal  $\frac{1}{4} p - \frac{b b}{p}$  in Heights, and  $\frac{b b}{p} - \frac{1}{4} p$  in Descents: From whence it follows, that all the Points  $b$ , are in the Curve of the Parabola, whose Focus is the Point from whence the Project is cast, and whose *Latus Rectum*, or *Parameter ad Axem* is  $= p$ . Likewise from the same Equation, may the least Parameter or Velocity be found capable to reach the Object proposed; for  $b b = \frac{1}{4} p p + p b$  being reduced  $\frac{1}{4} p$  will be  $= \sqrt{b b + b b + b}$  in Ascents, which is the Horizontal Range at forty five Degrees of Elevation that would just reach the Objects and the Elevation requisite will be easily had; for dividing the so found Semi-parameter by the Horizontal Distance given  $b$ , the Quote into Radius will be the Tangent of the Elevation sought.

The Rule may be of good Use to all Bombarders and Gunners, not only that they may use no more Powder than is necessary, to cast their Bombs into the Place assigned, but that they may shoot with much more Certainty, for that a small Error committed in the Elevation of the Piece, will produce no sensible Difference in the Fall of the Shot: For which Reason the *French Engineers* in their late Sieges have used Mortar-pieces inclined constantly to the Elevation of 45, proportioning their Charge of Powder, according to the Distance of the Object they intend to strike on the Horizon.

And this is all that need to be said concerning this *Problem*, of shooting upon Heights and Descents. But if a Geometrical Construction thereof be required, I think, I have one that is as easie as any that can be expected, which I deduce from the foregoing Analytical Solution, *viz.*

$$\frac{t}{r} = \frac{p}{2b} + \sqrt{\frac{\frac{1}{4}p^2p + p b - b b}{b b}} \text{ and 'tis this.}$$



Having made the Right Angle  $L D A$ , *Fig. 3.* make  $D A$ ,  $D F = p$ , or greatest Range,  $D G = b$  the Horizontal Distance,  $D B$ ,  $D C = b$ , the Perpendicular Height of the Object; and draw  $G B$ , and make  $D E =$  thereto: Then with the Radius  $A C$  and Centre  $E$  sweep an Arch, which if the Thing be possible, will intersect the Line  $A D$  in  $H$ ; and the Line  $D H$  being laid both ways from  $F$ , will give the Points  $K$  and  $L$ , to which draw the Lines  $G L$ ,  $G K$ : I say the Angles  $L G D$ ,  $K G D$  are the Elevations required for hitting the Object  $B$ . If below the Horizon, its Descent  $D C = D B$  must be laid from  $A$ , so as to have  $A C = A D + D C$ .

Note likewise, that if in Descents  $D H$  be greater than  $F D$ , and so  $K$  fall below  $D$ , the Angle  $K G D$  shall be the Depression below the Horizon. Now this Construction so naturally follows from the Equation, that I shall need say no more about it.

#### P R O P. VI.

*To determine the Force and Velocity of a Project in every Point of the Curve it describes.*

To this we need no other *Præcognita*, but only the third Proposition, *viz.* That the Velocity of Falling Bodies is double to that which in the same time would have described the Space fallen by an equable Motion: For the Velocity of a Project, is compounded of the constant equal Velocity of the Fall under a given Angle, *viz.* the Complement of the Elevation.

For Instance, in *Fig. 2.* in the time wherein a Project would move from  $G$  to  $L$ , it descends from  $L$  to  $X$ : And by the third Proposition, has acquired a Velocity, which in that time would have carried it by an unequal Motion from  $L$  to  $Z$ , or twice the Descent  $L X$ : And drawing the Line  $G Z$ , I say the Velocity in the Point  $X$ , compounded of the Velocities  $G L$ , and  $L Z$ , under the Angle  $G L Z$ , is to the Velocity impressed in the Point  $G$ , as  $G Z$  is to  $G L$ . This follows from the second Axiome; and by the 20th and 21st *Prop. Lib. 1. Con. Mydorgii*,  $X O$  parallel and equal to  $G Z$ , shall touch the Parabola in the Point  $X$ . So that the Velocities in the several



ral Points, as are the Lengths of the Tangents to the Parabola in those Points, intercepted between any two Diameters: And these again are as the Secants of the Angles, which those Tangents continued, make with the Horizontal Line G B.

From what is here laid down, may the Comparative force of a Shot in any two Points of the Curve, be either Geometrically or Arithmetically discovered.

#### C O R O L L A R Y.

From hence it follows, *That the Force of a Shot is always least at U, or the Vertex of the Parabola, and that at equal Distances therefrom, as at T and X, G and B, its Force is always equal; and that the least Force in U, is to that in G and B, as Radius to the Secant of the Angle of Elevation F G B.*

These Propositions considered, there is no Question relating to Projects, which by the Help of them may not be easily solved; and tho' it be true, that most of them are to be met withal, in *Galilæus*, *Torricellius* and others, who have taken them from these Authors; yet their Books being Foreign, and not easie to come by, and their Demonstrations long and difficult, I thought it not amiss to give the whole Doctrine here in *English*, with such short Analytical Proofs of my own, as might be sufficient to evince their Truth.

The Tenth Proposition contains a Problem, untouched by *Torricellius*, which is of the greatest Use in Gunnery; and for the Sake of which, this Discourse was principally intended: It was first solved by Mr. *Anderson*, in his Book of *The Genuine Use and Effects of the Gun*, Printed in the Year 1674; but his Solution required so much Calculation, that it put me upon Search, Whether it might not be done more easily? and thereupon in the Year 1678, I found out the Rule I now publish; and from it the Geometrical Construction: Since which Time there has a large Treatise on this Subject, Entitled, *L'Art de jetter les Bombes*, been published in France by Monsieur *Blondel*, wherein he gives the Solutions of this Problem by Messieurs *Bout*, *Romer* and *De la Hire*; but none of them being the same with mine, or in my Opinion more easie, and most of them more operose; and besides mine finding the Tangent, which generally determines the Angle better than its Sine, I thought my self obliged to Print it for the Use of all such as desire to be informed in the Mathematical Part of the Art of Gunnery.

Now these Rules were rigidly true, were it not, as I said before, for the Opposition of the Medium, whereby not only the direct imprest Motion is continually retarded, but likewise the Increase of the Velocity of the Fall, so that the Spaces described thereby, are not exactly as the Squares of the Times: But what this Opposition of the Air is, against several Velocities, Bulks, and Weights, is not so easie to determine. 'Tis certain that the Weight of Air, to that of Water, is nearly as 1 to 800, whence the Weight thereof, to that of any Project is given; 'tis very like-

ly, that to the same Velocity and Magnitude but of different Matter, the Opposition should be reciprocally as the Weights of the Shot; as likewise that to Shot of the same Velocity and Matter, but of different Sizes, it should be as the Diameters reciprocally: Whence generally the Opposition to Shot with the same Velocity, but of different Diameters, and Materials, should be as their Specifick Gravities unto their Diameters reciprocally; but whether the Opposition, to differing Velocities of the same Shot, be as the Squares of those Velocities, or as the Velocities themselves, or otherwise, is yet a harder Question. However it be, 'tis certain, that in large Shot of Metal, whose Weight many thousand times surpasses that of the Air, and whose Force is very great, in Proportion to the Surface where-with they press thereon; this Opposition is scarce discernable: For by several Experiments made with all Care and Circumspection with a Mortar-piece extraordinarily well fixed to the Earth on Purpose, which carried a solid Brass Shot of 4  $\frac{1}{2}$  Inches Diameter, and about 14 Pounds Weight, the Ranges above and below 45 Degrees were found nearly equal, if there were any Difference, the wider Ranges went rather the furthest, but those Differences was usually less than the Errors committed in ordinary Practice, by the unequal Goodness and Driness of the same sort of Powder by the Unfitness of the Shot to the Bore, and by the Looseness of the Carriage.

In a smaller Brass Shot of about an Inch and half Diameter, cast by a Cross-Bow, which ranged it, at most about 400 Foot, the Force being much more equal than in the Mortar-piece, this Difference was found more curiously, and constantly, and most evidently, the under Ranges outwent the upper.

From which Trials I conclude, that altho' in small and Light Shot, the Opposition of the Air, ought and must be accounted for; yet in Shooting of great and weighty Bombs, there need be very little or no Allowance made; and so these Rules may be put in Practice to all Intents and Purposes, as if this Impediment were absolutely removed.

Then after this in *Philosophical Transactions*, Numb. 261. The same excellent Geometrician pursues this Matter further in the following Discourse, viz.

#### *A Proposition of General Use in the Art of Gunnery, shewing the Rule of Laying a Mortar to pass, in order to strike any Object above or below the Horizon.*

It was formerly the Opinion of those concerned in Artillery, that there was a certain Requisite of Powder for each Gun; and in Mortars, where the Distance was to be varied, it must be done by giving a greater or lesser Elevation to the Piece. But now our later Experience has taught us, that the same thing may be more certainly and readily perform'd by increasing and diminishing the Quantity of Powder, whether regard be had to the Execution to be done, or to the Charge of doing it. For when Bombs are discharged with great Elevations of the Mortar, they fall too perpendicularly, and bury themselves



too deep in the Ground, to do all that Damage they might, if they came more oblique, and broke upon or near the Surface of the Earth; which is a Thing acknowledged by the Besieged in all who unpave their Streets to let the Bombs bury themselves, and thereby stifle the Force of their Splinters.

A Second Convenience is, that at the extream Elevation, the Gunner is not obliged to be so Curious in the Direction of his Piece, but it will suffice to be within a Degree or two of the Truth; whereas in the other Method of Shooting he ought to be very curious.

But a third and no less considerable Advantage is, in the saving of the King's Powder, which in so great, and so numerous Discharges, as we have lately seen, must needs amount to a considerable Value.

And for Sea Mortars, it is scarce practicable otherwise to use them, where the Agitation of the Sea continually changes the Direction of the Mortar, and would render the Shot very uncertain, were it not that they are placed about 45 Degrees of Elevation, where several Degrees above or under, make very little Difference in the Effect.

In Numb. 179. of these *Transactions*, I considered and demonstrated all the Propositions relating to the Motion of the *Projectiles*, and gave a Solution to this *Problem*, viz. *To hit an Object above or below the Horizontal Line with the greatest Certainty and least Force*, as may be seen in that *Transaction*, p. 16, 17. That is, That the Horizontal Distance of the Object being put  $= b$ , and the Perpendicular Height  $= h$ , the Charge requisite to strike the Object with the greatest Advantage, was that which with an Elevation of 45 Degrees, would cast the Shot on the Horizontal Line, to the Distance of  $\sqrt{b^2 + h^2} + h$ , when the Object was above the Horizon; or if it were below it, the Charge must be lesser, so as to reach on the Horizon, at 45 Degrees Elevation, no greater a Distance than  $\sqrt{b^2 + h^2} - h$ ; that is in the one Case, the Sum of the Hypothenufal Distance of the Object from the Gun, and the Perpendicular Height thereof above the Gun; and in the other Case, when the Object is below the Horizon, the Difference of the same, *per* 47. 1. *Euclid*.

And I then shewed how to find the Elevation proper for the Gun so charged, viz. As the Horizontal Distance of the Object, to the Sum or Difference of the Hypothenufal Distance, and Perpendicular Height :: So Radius to the Tangent of the Elevation sought. But I was not at that time aware that the aforesaid Elevation did constantly bisect the Angle between the Perpendicular and the Object, as is demonstrated from the Difference and the Sum of the Tangent and Secant of any Arch being always equal to the Tangent and Co-tangent of the half Complement thereof to a Quadrant.

Having discovered this, I think nothing can be more compendious, or bids fairer to compleat the Art of *Gunnery*, it being as easie to shoot with a Mortar at any Object on Demand, as if it were on the Level: Neither is there need of any Computation, but only simply laying the Gun to pass, in the middle Line between the Zenith and the Object, and giving it its due Charge. Nor is

there any great Need of Instruments for this Purpose: For if the Muzzle of the Mortar be turned truly Square to the Bore of the Piece, as it usually is, or ought to be, a Piece of Looking-glass Plate applied Parallel to the Muzzle, will by its Reflection give the true Position to the Piece; the Bombardeer having no more to do, but to look perpendicularly down on the Looking-glass, alongst a small Thread with a Plummets, and to raise or depress the Elevation of the Piece, till the Object appear reflected on the same Point of the Speculum, on which the Plummets falls; for the Angle of Incidence and Reflection being equal, in this Case a Line at Right Angles, to the Speculum, as is the Axis of the Chase of the Piece, will bisect the Angle between the Perpendicular and the Object, according as our Proposition requires. So that it only remains by good and valid Experiments to be assured of the Force of Gun-powder. How to make and conserve it equal, and to know the Effect thereof in each Piece; that is, how far the differing Charges will cast the same Shot out of it; which may most conveniently be engraven on the outside thereof, as a standing Direction to all Gunners, who shall from thenceforward have Occasion to use that Piece: And were this Matter well ascertained, it might be worth the While to make all Mortars of the like Diameter, as near as may be alike in Length of Chase, Weight, Chamber and all other Circumstances.

This Discovery that the utmost Range on an inclined Plane is, when the Axis of the Piece makes equal Angles with the Perpendicular and the Object, compared with what I have demonstrated of the same *Problem* in the aforesaid Number 179, does lead to and discover two very ready *Theorems*; the one to find the greatest Horizontal Range at 45 Degrees Elevation by any Shot made upon any inclined Plain with any Elevation of the Piece whatsoever: And the other to find the Elevations proper to strike a given Object with any Force greater than what suffices to reach it with the aforesaid middle Elevation. Both which being performed by one single Proportion, may be very serviceable to such as are concerned in the Practice of *Gunnery*, but are unwilling to trouble themselves with tedious and difficult Rules.

The Two Propositions are these.

#### P R O P. I.

*A Shot being made on an inclined Plane, having the Horizontal Distance of the Object it strikes, with the Elevation of the Piece, and the Angle at the Gun between the Object and the Perpendicular: To find the greatest Horizontal Range of that Piece, laden with the same Charge; that is, half the Latus Rectum of all the Parabolæ, made with the same Impetus.*

#### R U L E.

Take half the Distance of the Object from the Nadir, and take the Difference of the given Elevation from that half; the Versed Sine of twice that difference Subtract from the Versed Sine of the Distance of the Object from the Zenith: Then shall the Difference of those Versed Sines



be to the Sine of the Distance of the Object from the Zenith, as the Horizontal Distance of the Object struck, to the greatest Horizontal Range at 45 Degrees,

## P R O P. II.

*Having the greatest Horizontal Range of a Gun, the Horizontal Distance, and the Angle of Inclination of an Object to the Perpendicular, to find the two Elevations necessary to strike that Object.*

## R U L E.

Halve the Distance of the Object from the Nadir, this half is always equal to the half Sum of the two Elevations we seek. Then say, As the greatest Horizontal Range is to the Horizontal Distance of the Object: So is the Sine of the Angle of Inclination or Distance of the Object from the Perpendicular to the fourth Proportional; which Fourth being subtracted from the Versed Sine of the Distance of the Object from the Zenith, leaves the Versed Sine of half the Difference of the Elevation sought; which Elevations are therefore had by adding and subtracting that half Difference to and from the aforesaid half Sum.

I shall not need to speak of the Facility of these Solutions: I shall only observe, that they are both general without Exception or Caution, and derived from the Knowledge that these two Elevations are equi-distant above and below the Line, bisecting the Angle between the Object and the Zenith.

ORDONANCE, in Architecture is the giving to all the Parts of an Edifice that just Quantity and Dimension which they ought to have, according to the Model.

ORDONANCE, in Painting or Sculpture, is the just and elegant Composition of the whole Piece by a proper, natural, and agreeable Disposition of the Figures, so as to answer the Design of the History.

OREXIS, is the Natural Appetite of Meat, which proceeds from an acid Ferment in the Ventricle that comes from the *Cæliac* Arteries, with which the nervous Tunick of the Stomach and its Nerves are extraordinarily moved to co-vet Nourishment. *Blanchard.*

ORGANICAL Part, is that Part of an Animal or Vegetable Body which is designed for the performing some particular Action: Whereas some Parts are *Non Organical*; which have no particular Action, but rather some Use in the Oeconomy of the Whole.

ORGANICAL Description of Curves, is the Method of Describing them on a Plane by the Regular Motion of a Point. See some excellent short Theorems for this, invented by Sir *Is. Newton*, under the Word *Curves*.

ORGANS, the Parts of an Animal Body, fitted as Instruments to discharge any particular Office or Function. Thus the Organ of Sight is the Eye with all its Parts; the Organ of Hearing is the Ear, &c. therefore by *Organical Parts* are meant the Substantial Parts or Members of the Body, appointed to perform any particular Function or Action.

ORGANUM, or *Organon*, the Name or Title that *Aristotle* gave to his Book of Logic.

ORGASMUS, is an *Impetus* and quick Motion of Blood or Spirits; as when the Animal Spirits rush violently into the Nerves.

ORIENT, is the East Quarter of the *Horizon* or is that Part of the *Horizon* where the *Ecliptick*, or the Sun therein, ascends into the upper Hemisphere; and therefore, according, to some Writers way of Expression, the

*Estival* ORIENT, is that Point of the *Horizon* where the Sun rises, when he enters into *Capricorn*.

*Equinoctial* ORIENT, is that Point of the *Horizon* which the Sun rises upon, when he enters into *Aries* or *Libra*.

ORIENTAL, in Astronomy: A Planet is said to be *Oriental*, when it rises in the Morning before the Sun.

ORIFICE, the Mouth, Entry, or Brim of any thing, more-especially that of a Wound, Vein, Tube, &c.

ORIGINAL *Equations*. A Term used by *Harriot* in his Algebra; See *Quadratick Equations*.

ORIGINALIA, in the Treasurer's Remembrancer's Office in the *Exchequer*, are Records or Transcripts sent thither out of the *Chancery*, and are distinguished from *Recordæ*, which contain the Judgments and Pleadings in Suits tryed before the Barons of that Court.

ORIGINALIA, is the Term for Records or Transcripts sent out of the *Chancery* into the Lord Treasurer's Remembrancer's Office in the *Exchequer*: These are distinguished from *Recordæ*, which signify the Judgments and Pleadings in Suits try'd before the Barons of that Court.

ORILLON, in Fortification, is a small Rounding of Earth lined with a Wall, which is raised on the Shoulder of those Bastions that have Casements, to cover the Cannon in the Retired Flank, and prevent their being dismounted by the Enemy.

There are also other Sorts of *Orillons*, properly called *Shoulderings*, which are almost of a Square Figure: They are also called *Epaulements*.

ORION, in Astronomy, one of the Constellations of the Southern Hemisphere,

The Antients supposing that it raised Tempests at its Rising and Setting.

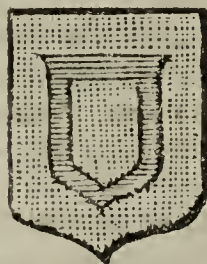
*Stars* in the Constellation *Orion*, in *Ptolemy's* Catalogue are 37, in *Tycho's* 62, in the *Britannick* Catalogue 80.

ORGUES, in Fortification, are many Harquebusses link'd together, or divers Musket-Barrels laid in a Row, within one Wooden Stock, so that they may be discharged either all at once, or separately. They are made use of to defend Breaches and other Posts that are attacked.

This Term is also appropriated to certain long and thick Pieces of Timber, armed with Iron Plates at the Ends, and separated one from another. They are hung with Cords over the Gates of a Town or Fortrefs, and in Case of a Surprise, let fall perpendicular; by which means the Passage is stopt, so that the Enemy cannot easily remove or hoist up all the Wooden Bars with a Leaver, or any other Machine set under them: On which Account these *Orgues* are to be prefer'd before *Herfes* or *Portcullices*, because the Pieces



whereof the latter consist are joined together; so that when any part is hung or heaved up, the whole Machine is likewise removed. These *Orgues* therefore are much better than *Portcullices*.



ORLE, is an Ordinary in Heraldry, almost of the Figure of an *Inescutcheon*, only it is voided, so that the Field appears through, Thus: He beareth *Or*, an *Orle Azure*, by the Name of *Bertram*. Whenever an *Orle* is flowered, it is called a *Tressure*; and if there

be two of them a *Double Tressure*.

Sometimes an *Orle* consists of three Pieces one with another. Also if a Round of *Martelets*, *Cinquefoils*, *Escallop-Shells*, &c. are placed about any Ordinary, 'tis called an *Orle* of *Martelets*, *Cinquefoils*, &c.

ORLE, a Term in Architecture; the same with *Plinth*, which see.

ORLOPE, properly the Spare Deck in a great Ship, reaching from the Main-mast to the Mizen; and in a Three-deck'd Ship the Second and lowest Deck are sometimes called *Orlopes*.

ORNAMENTS, in Architecture, are the *Architraves*, *Friezes* and *Cornices* of the several *Orders*. But there are also many Ornaments frequently carved in the Mouldings, and on all other Members; as divers Sorts of *Leaves*, *Channellings*, *Wreaths*, *Ovals*, *Chaplets*, *Tresses*, *Festoons*, *Flowers*, *Roses*; &c. The Ornaments of the Columns the French call *Oeufs*.

ORNITHOLOGY, [*ὀρνιθολογία* Gr.] is a Description of the several Natures and Kinds of Birds.

OROBIDES, is a subsiding in Urine, like to a Kind of Pulse called *Vetches*. *Blanchard*.

ORTEIL, a Term in Fortification; the same with *Berme*, which see.

ORTHODROMIQUES, [*ὀρθόδρομια* of *ὀρθός* *Right*, and *δρομή* Gr. a *Course*] is the Art of sailing in the Ark of some great Circle: For the Ark of every great Circle is *ὀρθόδρομια*, the shortest straightest Distance between any two Points on the Surface of the Globe.

ORTHOGRAPHY, [of *ὀρθογραφία* of *ὀρθός* and *γραφία* Gr. *Writing*] in Grammar, is writing and spelling any Language truly, according, to its just Etymologies and Proprieties.

ORTHOGRAPHY, in *Mathematicks*, is the true Declination of the fore-right Plain of any Object.

In *Architecture*, 'tis taken for the Model, Platform, and Delineation of the Front of a House that is to be built and contrived according to the Rules of Geometry; according to which Pattern, the whole Fabrick is erected and finished.

In *Perspective*, the *Orthography* of any Body, or Building, is the Fore-right side of any Plane; that is, the Side or Plane that lies parallel to a straight Line, that may be imagined to pass thro' the outward Convex Points of the Eyes, continued to a convenient Length. The Word *Schegnography* is used by *Lamy* and others in the same Sense.

In *Fortification*, it is the *Profile* or Representation of a Fortrefs, made after such a Manner, that the Length, Breadth and Height of its several Parts may be discovered.

ORTHOGRAPHICAL *Projection of the Sphere*, is the drawing of the Superficies of the *Sphere* on a Plane which cutteth it in the middle, the Eye being placed at an infinite Distance vertically to one of the *Hemispheres*; then a Right Line extended from the Eye to any assigned Point in the Surface of that Hemisphere, shall project the assigned Point upon the Plane; and the Distance upon the Plane from the Apex, or Top of the Hemisphere to the projected Point, is equal to the Sine of the Ark, from the Vertex of the Hemisphere to the assigned Point, the Radius being the Semi-diameter of the *Sphere*. This Projection is also called the *Analemma*, which see.

ORTHOGONIAL, [*ὀρθόγων* of *ὀρθός* and *γωνία* Gr.] the same with *Right-Angled*; and when referred to a Plain Figure, supposes one Leg or Side to stand perpendicular to the other: And when it is spoken of Solids, it supposes their Axes to be Perpendicular to the Plane of the Horizon.

ORTHOPNOEA, is an ill Spiration, when the Person affected cannot breathe but with his Neck erect.

ORTIVE [in *Astronomy*] as *Ortive Amplitude* is the Eastern Amplitude, and an Arch of the Horizon intercepted between the Point where a Star rises, and the East Part of the Horizon, or the Point, where the Horizon and Equator intercept.

OS, a Bone is an hard, dry and cold Substance, consisting especially of earthy and saline Particles, which Particles, saith Dr. *Havers*, being in their several Series united at their Extremities, form Strings; and those Strings united make distinct Plates, which lying one above another, constitute the whole Thickness of the Bone.

The Bones in a Human Body are designed for the upholding of the Body, to render its Motion easie, and for a Fence for several Parts. Some make the Number of the Bones to be 249, others commonly 304, and others as many as the Days of the Year; yet the Number of them is uncertain, because the Bones of Infants differ from those of Adult Persons; also, because the Bones called *Sesamoidea*, (see them in their proper Place) and the Teeth, are not determined to a certain Number in Old Men and Adult Persons. They are of different Shapes; some are round, others plain, acute, obtuse, hollow, spongy, solid, oblong, triangular, &c. If you would find any particular Bone, see the Word that distinguishes it; as, for *Os Frontis*, or *Coronale*; see *Frontis Os*, or *Coronale*.

OS *Calcis*. See *Calcaneus*.

OSCHEOCELE, [of *ὄσχεον* the *Scrotum* and *κύλη* Gr. a *Tumour*] a Kind of Rupture or Hernia, where the Intestines descend into the *Scrotum*.

OSCILLATION. If a Ball be hung at the End of a String or Wire, and that Wire or String hang on a Pin fastened above, so that the Ball may swing or play freely on that Pin, it is called a *Pendulum*, and the Pin is the *Centre of Suspension*: But if you imagine the Pin to be the Centre of a Circle, whose Circumference shall divide the Ball or Bob into two equal Parts, the middle Point of the Ark, so dividing the Ball, is called the *Centre of Oscillation*. If the Bob be of any other Figure but orbicular, the Centre of Gravity of it will be the Centre of Oscillation.



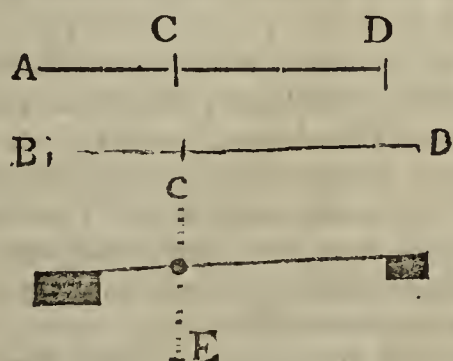
N. B. The shorter the *Oscillations* or Swings are, the truer will the *Pendulum* measure Time; or the more *Isochrone* will the *Vibrations* be, as some love to express themselves.

To find the Centre of Oscillation exactly, in order to adjust the Royal Pendulum of a Clock, Mr. Huygens gives this Proportion, (*Horol. Oscillat.* p. 141.)

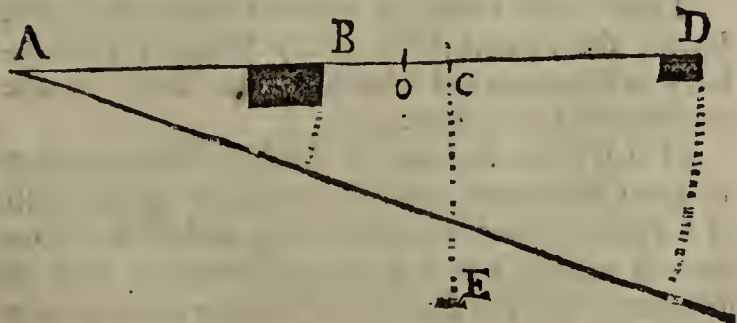
As the Length of the String from the Point of Suspension, to the Centre of a Ball or Bob: is to the Semi-diameter of that Ball or Bob :: so is that semi-diameter to a fourth Number.

Add  $\frac{2}{3}$  of that Fourth Number to the former Length, and you have the *Centre of Oscillation*.

But this Term, the *Centre of Oscillation* is often in *Mechanicks* taken in a more large and comprehensive Sense. As suppose there be a *Libra*, as B D, having the Weights B and D,



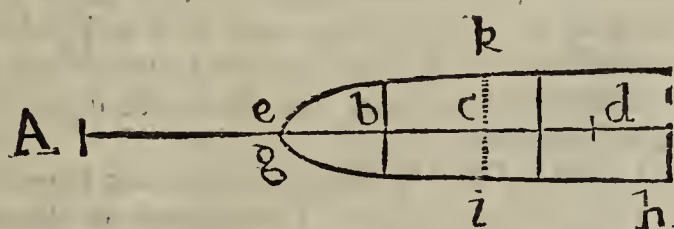
hanging at its ends by their Centres of Gravity B and D; and let the Point C be the *Hypomochlion*, *Fulcriment* or Prop which is supposed to support the *Libra* in the common Centre of Gravity C, belonging to the two Bodies B and D; then will those Weights be in *Æquilibrio*. Let this *Libra*, with the Weights C and D hanging at it, descend perpendicular to the Horizon all together, and still retain a Parallelism to its self in its first Situation; and as it thus moves, let it meet with an Obstacle, as E, which shall strike it in C, the above-mentioned common Centre of Gravity: Then because the Descent of the *Libra* was by a parallel Motion, the Points B and D will have acquired equal Velocities; and consequently the Weights hanging at such Points will also gain equal Velocities; and therefore if the *Libra* strike upon E, the *Æquilibrium* must continue the same as before, that is, will not *oscillate* or swing any way, but keep at Right Angles with the Line C E: Wherefore C is both the common Centre of Gravity, and also of Oscillation.



But supposing the *Libra* to turn round the Centre A, or to swing on it like a *Pendulum*, with its Weight B and D affixed to it, as before: In this Case will the Weights B and D acquire each a Degree of Velocity, proportionable to their respective Distances from the Centre. And consequently if *o* (suppose) had been their common Centre of Gravity, before the new Rotation of the *Libra* round A, it cannot now be the Point on which the Revolving Bodies B and D will poize, or be in *Æquilibrio*: That is, the Point *o* cannot be the Centre of Oscillation.

For since *o* is supposed to be the common Centre of Gravity, therefore the Moment of B O  $\times$  B, must be equal to the Moment of D O multiplied by D: But since the Velocity of B is to that of D, as A B is to A D; therefore the Compound Moment of B  $\times$  B O  $\times$  A B cannot be equal to the compound Moment of D  $\times$  D O  $\times$  A D; and consequently there cannot be an *Æquilibrium* about the Point *o*: Wherefore if an *Obex* or Obstacle should meet with the *Libra* in the Point *o*, the *Libra* would oscillate or dip towards the Parts of D, because that *Momentum* is the greater of the two. But the true Centre of Oscillation will be a point as C, taken so, that the Moment of B  $\times$  B C  $\times$  A B, shall be equal to the Moment of B  $\times$  D C  $\times$  A D. That is if A D. A B :: B  $\times$  B C. D  $\times$  D C, then will C be the true Centre of Oscillation; and if the Revolving *Libra* should be supposed to meet with an *Obex*, it would not oscillate upon it.

In like manner, if instead of a *Libra* burden'd with two Weights, as above, we conceive any plain or solid Figure to revolve about the Centre A, its Centre of Oscillation is to be determined by the same Principle.



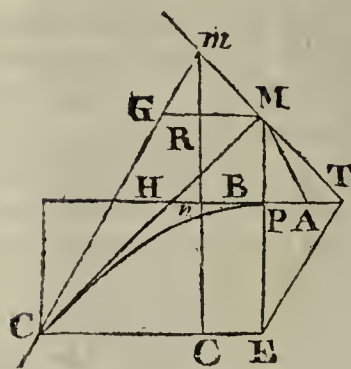
Thro' the Point C of the Revolving Figure taken in the Axis e d, let the Line k i be drawn, dividing the Figure into two Parts, e k i g, and k f h i; the Centres of Gravity of which Parts suppose to be at b and d: Then if the Compound Moment of i e, k c  $\times$  b c  $\times$  A b = k f h i  $\times$  c d  $\times$  A d: for the same Reason as before, C will be the Centre of Oscillation.

This I had from Mr. Humphry Ditton.

OSCITATION, Yawning, is a certain light Convulsive Motion of those Muscles which open the lower Jaw of the Face. Some think that Excrementitious and Halituous Matter, which irritates the neighbouring Parts, is expelled by this Action of Yawning.

OSCUA, are the Openings of Vessels in an Animal Body, at their Ends.





the Curve.

The Line M C, is also called the Radius of of the *Osculum*: The Evolute B C E, is the Place of the Centres of all the Circles that osculate the Curve A M I, described by Evolution.

The Doctrine of the *Oscula* of Curves, is owing to Monf. *Leibnitz*, who first shewed the Use of *Huygens* Evolute in measuring the Curvatures of Curves.

OSCULATORIUS Musculus. See *Orbicularis*.

OS Mali. See *Zygoma*.

OS Unguis. See *Unguis Os*.

OS Occipitis. See *Occipitis Os*.

OS Palati. See *Palati Os*.

OSSA Parietalia. See *Parietalia Offa*.

OSSA Temporum. See *Temporum Offa*.

OS Sphæroides. See *Sphæroides*.

OSSICULUM, among the Botanists is the Stone of a Plum, Cherry, or such like Fruit.

OSTENSIVE Demonstrations, are such as plainly and directly demonstrate the Truth of any Proposition; in which they are distinguished from *Apogogical* ones, or *Deductiones ad Absurdum*, sive *ad impossibile*, which prove the Truth proposed, by demonstrating the Absurdity or Impossibility of asserting the contrary.

OSTENSIVE Demonstrations, are of two Sorts: Some of which barely (but directly) prove the Thing to be, which they call *ὅτι*; and Others demonstrate the Thing from its Cause, Nature, or essential Properties, and these are called in the Schools *διότι*.

OSTEOLOGIA, [*ὀσσεολογία* of *ὀσσεον* a Bone and *λέγω* Gr. to treat of] is a Description of Bones.

OSTEOCOPI, [*ὀσσεον* a Bone and *κόπος* Gr. Pain] are Pains in the Bones, or rather in the Membranes and Nerves about the Bones: For Bones, as such, are insensible. *Blanchard*.

OSTINEÆ, so some Anatomists call the Entrance into the Cavity of, or the Mouth of the *Matrix*, where it joins the upper End of the *Vagina*, and makes a little Protuberance in the Form of Lips.

OTACOUSTICKS, [*ὠτακουστικά* of *ὠτος* an Ear and *ακούω* Gr.] are Instruments which help or improve the Sense of Hearing. See *Acoustica*.

OTALGIA, [*ὠταλγία* of *ὠτος* and *ἄλγος* Gr. Pain] is a Pain in the Ears whencesoever it proceeds.

OTENCHYTA, [*ὠτεγχύτης* Gr.] an Auricular Clyster. *Celsus* calls it *Oegin*, a little Syringe or Squirr which injects Medicines into the Ears.

OTICA, [*ὠτικά* of *ὠτος* Gr. the Ear] are Medicines against Distempers in the Ears.

OVAL, in Architecture, the same with *Echinus*. Some write it *Ovolo*, because of its Figure, being like an Egg. It is placed in the Mouldings of the Cornices for Ornament; and in a Pillar it is placed next the *Abacus*,

OVAL Figure, in Geometry, is a Figure bounded by a regular Curve Line returning into its self; but of its two Diameters cutting each other at Right Angles in the Centre; one is longer than the other, in which it differs from the *Circle*. See *Ellipsis*.

OVAL Window, one of the Holes in the Hollow of the Ear, opening pretty wide into the *Labyrinth*; the other being called the *Round Window*.

OVARIA, are the Testicles of Females, and are so called, because they resemble and have the same Use as the Lathers or Collections of Eggs in the Bodies of Fowls.

The *Ovaria* in Women are about half as big as the *Testicles* in Men; their Surface is smooth and equal in Virgins, but in Women of Years unequal and wrinkled. They are covered with a proper Membrane, which sticks close to their Substance, and with another common from the *Peritonæum*, which covers also the *Spermatick Vessels*. The Substance of the *Ovaria* is composed of Fibres and Membranes, which leave little Spaces, in which there are several small Vesicles, round, full of Water, and which when boiled, harden like the Whites of Eggs; they have each of them two proper Membranes, on which there are several small Twigs of Veins, Arteries and Nerves. These Vesicles are called *Eggs*. The *Ovaria* have Nerves also from the *Intercostals*, and *Lymphatics*, which discharge themselves into the common Receptacle of the Chyle.

OVELTY of Services, in Law, signifies Equality of Services; as when the Tenant Paravail owes as much to the Mesne, as the Mesne does to the Lord Paramount.

OVERT-Rake, when a Ship, riding at Anchor, doth so over-beat herself into a Head-Sea that she is washed by the Waves breaking in upon her then they say the Waves do *Over-rake* her.

OVERT-ACT, a Term in Law, signifying Open ACT, which may be manifestly proved.

OVIDUCTUS, the same with *Tuba Fallapiana*.

OVIPAROUS Animals are such as lay Eggs.

OUNCE, *Uncia*, a little Weight, the sixteenth Part of Pound Averdupois; and the twelfth of a Pound Troy.

The *Ounce Averdupois* is divided into eight Drachms, and the Dram into three Scruples: The *Ounce Troy* into twelve Penny-weights, and the Penny-weight into twenty four Grains.

The *Ounce* makes the eighth Part of the *French Mark*, and is divided into three Gros or Drachms; the Drachms into three Penny-Weights or Scruples; and the Scruple into 24 Grains; each Grain computed to weigh a Grain of Wheat.

All precious Merchandizes, as Gold, Silver, Silk, &c. are sold by the Ounce.

The Word *Ounce* is derived from the Latin *Uncia*, the twelfth Part of any Whole; particularly in Geometrical Measures, an Inch, or the twelfth Part of a Foot.

OVOLO or *Echinus*, in Architecture is a Part of the Ornaments, or Mouldings of the Cornish of a Pillar; which in the Tuscan and Dorick Orders is turned like a *Scima* or *Cymatium*, and is substituted for the Support of the *Corona*; in the *Dorick Order* it usually hath a slender *Regula* above



above it, and in the *Corinthian* both above and below too, where it is likewise carved and adorned with a broad *Welt* like a *Plinth*.

**OUSTER** *la main*, in a legal Sense denotes a Judgment given for him that sued or traversed a *Monstrans le Droit*; and is indeed a Delivery out of the King's Hands; for when it appeareth on the Matter discussed, that the King hath no Right or Title to the Thing seized, then Judgment shall be given in the Chancery, that the King's Hand be *amoved*, and thereon an *Amoveas Manum* or *Ouster la main* shall be awarded to the Escheator; which is as much as if Judgment were given that he should have his Land again. Now, all Wardships, Liveries, Premier Seifins, and *Ouster la mains* are taken away by 12 Car. 2. c. 24.

**OUTACOUSTACON**, an Ear-pipe to augment Hearing.

**OUTFANGETHEF**, was a Privilege granted to some Lords of Mannors from the Crown, to try Foreigners or Strangers apprehended for Theft within their own Fee.

**OUTLAW**, signifies one deprived of the Benefit of the Law, and out of the King's Protection.

**OUTLAWRY**, is the Loss of the Benefit of a Subject, that is, of the King's Protection. See *Utlawry*.

**OUTLICKER**, in a Ship, is a small piece of Timber three or four Yards long, as Occasion serves, and is made fast to the Top of the Poop, and so stands right out a-stern: At the outmost end of it is a Hole, into which the standing Part of the Sheet is reeved and made fast through the Block of the Sheet; and then again reeved thro' another Block, which is seized to this Outlicker, hard by the End of it. This is seldom used in Men of War, or in great Ships; and whenever it is made use of, it is because the Mizen-mast is placed so far *ast*, that there is not room enough within Board to hale the Sheet flat.

**OUTRIDERS**, in Law, are Bailiffs Errant employed by the Sheriffs, or other Deputies to *ride* to the farthest Places of their Counties or Hundreds, with the more Speed to summon such as they thought good to their County or Hundred Courts.

**OUTWARD Flanking-Angle**, or the *Angle of the Tenaille*, is comprehended by the two Flanking Lines of Defence:

**OUT-Works**, in Fortification, are all Sorts of Works, which are raised without the Inclosure of a Place, and serve for its better Defence, and to cover it from the Enemy, in the Plain without; as *Ravelins*, *Half-moons*, *Horn-works*, *Crown-works*, *Counter-guards*, *Tenailles*, &c.

It is a general Rule in all Out-works, that if there be several of them one before another to cover one and the self-same *Tenaille* of a Place, the nearer ones must gradually and one after

another, command those which are farthest advanced out into the Campaign; that is, must have higher Ramparts, that so they may over-look and fire upon the Besiegers, when they are Masters of the more outward Works.

The *Gorges* also of all Outworks must always be plain, and without Parapets; lest, when taken, they should serve to secure the Besiegers against the Fire of the retiring Besieged; wherefore the *Gorges* of Out-works are only Pallisado'd, to prevent a Surprise.

**OUVERTURE**, is a kind of Musick, usually played at the Opening or Beginning of an Opera; it commonly ends with a *Fugue*.

**OVUM**, by some Writers, is a Name given to a certain Pain in the Head, affecting one particular Spot, no bigger than the End of an Egg; whence the Name.

**OWELTY**, in Law, is when there is Lord, Mesne, and Tenant: and the Tenant holds of the Mesne by the same Service that the Mesne holds over the Lord above him: This is called *Owerty of Services*. See *Ovelty*.

**OXELÆUM**, [*ὀξέλαιον* Gr.] is a Mixture of Vinegar and Oil.

**OXYCRATUM**, [*ὀξύκρατον* Gr.] is a Mixture of Vinegar with Water, called *Pusca* or *Posca*.

**OXYDERCIA**, [*ὀξοδερχία* Gr.] are Medicines which quicken the Sight.

**OXYGALE**, [*ὀξύγαλα* Gr.] is four Milk.

**OXYGONE**, [*ὀξύγωνιος* Gr.] the same with an *Acute-Angled Triangle*; which see. And in the General.

**OXYGONIAL**, is *Acute-Angular*.

**OXYMEL**, [*ὀξύμελι* Gr.] is a Composition of Vinegar and Honey, like a Syrup.

**OXYREGMIA**, [*ὀξύρεγμία* Gr.] is an acid sowre Belch from the Stomach.

**OXYRHODINUM**, [*ὀξύρόδιον* Gr.] is Vinegar of Roses mixed with Rose-water.

**OYER** and *Terminer*, in Law, is a Commission especially granted to some eminent Persons for the hearing and determining one or more Causes: It is the first and largest of the Comissions, by which the Judges of Assize do sit in their several Circuits.

**OYER de Record**, is a Petition made in Court, That the Judges for better Proofs Sake will be pleased to hear or look upon any *Record*. So when any Action is brought upon an Obligation, the Defendant may pray *Oyer* of the Bond; or if Executors sue for any one, the Party sued may demand *Oyer* of the Testament.

**O YES**, is a Corruption from the French *Oyez!* hear ye! being the Form used by our Criers in Courts, &c. to make Proclamation of any Thing.

**OZAENA**, [*ὀζαίνα* Gr.] is an old stinking Ulcer in the inside of the Nostrils, taking its Name from the Fulsomeness of its Smell.



## P.

**P.** [in *Physical Inscriptions*] signifies *Pugil* 4 or the Eighth Part of the Handful.

**PE**, [in *Physical Prescriptions*] stands for *Partes æquales*, 4 equal Parts of any Ingredients, otherwise denoted by a *Orana*.

**PM**, [in *Astronomy*] frequently signifies *post Meridiem* or *Afternoon*, and sometimes for *post Mane* 4 after *Morning*, i. e. after *Midnight*.

**PP**, [in *Physical Prescriptions*] is used for *Pulvis Patrum* 4, i. e. the Jesuit's Powder or Jesuit's Bark, so called, because first brought into *Europe* by those Fathers.

**PACE** [*Passus* 4, a *Step*] a Measure taken from the Space between the two Feet of a Man in walking, which is ordinarily 2 Feet and a half, the *Geometrical* or *German Pace* is 5 Feet.

**PACHUNTICK** Medicines [*παχυντικά* of *παχύς* Gr. to render *thick, dense, &c.*] are such as are of a thickening Nature, but withal cold; these when mix'd with a thin Juice, by joining the Parts together stiffen it, and make it of a more Dense, and firm Composition: Such as *Bole-Armoniack*, *Almonds*, *Poppies*, *Water-Lillies*, &c. *Blanchard*.

**PACK of Wool**, is a determinate Quantity of 17 Stone and two Pound Weight, being a common Horse Load.

**PACTUM** *Commissorium*, in the Civil Law, is an Agreement between Buyer and Seller, but on this Condition, that if the Price contracted for be not paid before a certain Day, that then the Bargain shall be void.

**PAINE** *fort & dure*, in Law it signifies an especial Punishment from him that being arraigned of Felony, refuses to put himself upon the ordinary Trial of God and his Country, and thereby stands Mute by the Interpretation of the Law.

And is thus described by *Stamford*.

“ He shall be sent back to the Prison, whence  
 “ he came, and laid in some low dark House,  
 “ where he shall lie naked on the Earth, without  
 “ any Litter, Rushes, or other Cloathing,  
 “ and without Rayment about him, but only  
 “ something to cover his Privy Members: And  
 “ he shall lie upon his back, with his Head covered  
 “ and his Feet; and one Arm shall be drawn  
 “ to one Quarter of the House with a Cord,  
 “ and the other Arm to another Quarter,  
 “ and his Legs used in the same Manner; let  
 “ there be laid upon his Body, Iron and Stone as  
 “ much as he may bear, or more: And the next  
 “ Day following he shall have three Morsels of  
 “ Barly-Bread, without Drink; and the second  
 “ Day he shall have Drink three times, as much  
 “ at each time as he can drink of the Water  
 “ next unto the Prison, except it be running  
 “ Water, without any Bread: And this shall be  
 “ his Diet till he Die.”

This Sort of Punishment, called by the Law *Paine forte & dure*, is that which is vulgarly called *Pressing to Death*.

**PAINTING**: Books treating of this Art, and of the Eminent Artists are as follow.

*An Idea of the Perfection of Painting: Originally written in French by Rowland Treart, Sieur de Cambray, and render'd English by J. Evelyn, Esq; F. R. S. Lond. 1668 8vo.*

*A General Idea of the Art of Painting, and a Relation of 7 Conferences held at Paris in the Academy Royal for the Improvements of the Art of Painting and Sculpture.*

*Optique de Portraiture & Peinture, contenant la Perspective Speculaire & Pratique Accomplie. &c. per Gregorie Huret de l'Academ, Royale de Peinture & Sculpture, à Paris 1670. Fol.*

*Entretiens sur les Vies & sur les Ouvrages des plus Excellens Peintres Anciens & Modern, per M. Felibien.*

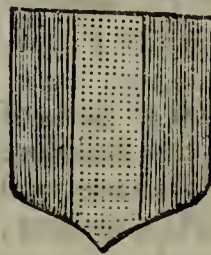
**PALATI** *Os*, is a small Bone almost Square, it makes the posterior Part of the Roof of the Mouth: It is joined to that Part of the *Os Maxillare*, which makes the fore-part of the Palate; it is also joined to its Fellow, and the *Processus Pterigoidæus*. It has a small Hole, thro' which a Branch of the fifth Pair of Nerves goes to the Membrane of the Palate.

**PALATO-Salpingæus**, a Muscle of the *Tuba Eustachyana*. See *Musculus Tubæ Novus*.

**PALATO-Staphilius**, is a Muscle of the *Uvula*, arising fleshy from the middle of the *Os Palati*, near its juncture with its Fellow of the other Side, and running strait forwards, it is inserted near the Extremity of their duplicated glandulous Membrane called the *Gargareon*: Its Use is to pull it forwards and downwards. *Dr. Dowglass, Myogr. Comp. Spec.*

**PALATUM**, the Palate, is the upper Part of the Mouth, which because it resembles the Roof of an House, is thence called the *Roof of the Mouth*.

**PALE**, one of the Eight Honourable Ordinaries in Heraldry, containing the third Part of the *Escutcheon*, thus:

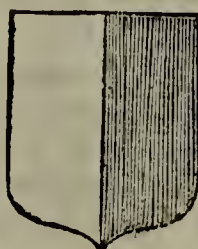


He beareth *Gules*, a *Pale Or*.

In **PALE** [in *Heraldry*] signifies Things borne one above another in the Nature of a Pale.



**PALES** [in *Heraldry*] is when a Shield is divided into four or more equal Parts by Perpendicular Lines falling from the Top to the Bottom. See the *Escutcheon*.



**Party per PALE** [in *Heraldry*] signifies a Shield divided by one single Line, thro' the Middle from the Top to the Bottom, which is the Nature of a Pale. See the *Escutcheon*.

*Party*



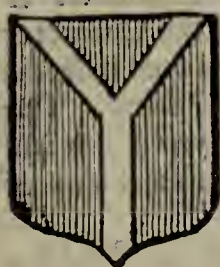
**PALED Flowers** [in *Botany*] are such as have Leaves set about or surrounding a Head or Thrum, as in Marygolds, &c.

**PALLIATION**, in Architecture is the *Piling* the Ground-work, or strengthening it with Piles or Timber driven into the Ground, when they build upon a *Moist* or *Marshy Soil*. *Builders Dictionary*.

**PALLICIUM**, [in *Astronomy*] a fixt Star of the first Magnitude in the Bull's Eye, called also *Aldebaran*. Its Longitude is 50. 27. 00". and Latitude 5°. 29'. 49". according to Mr. *Flamsteed's* Catalogue.

**PALINDROME**, [παλινδρομια Gr. a *Running back*] is a Disease into which one relapses. *Blanchard*.

**PALINTOCIA**, [παλιντοκία of πάλιν and τίκω a *Birth of τίκω* Gr. to bring forth] a Delivery of a Child the second time; also the Repetition of Usury.



**PALL**, the Heralds have a kind of Cross, which they call by this Name, and they describe it thus:

He beareth Gules a Cross Pall Argent.

**PALLET**, is the Moiety, or half of the *Pale*, and must never be charged with any thing either Quick or Dead; neither can it be divided into two equal Parts, but it may into four, for one fourth Part of the *Pallate*, or  $\frac{1}{8}$  part of the *Pale*, is called an *Endorse*.

If the *Pale* be upon any Beast, they say the Beast is *Debruised with the Pale*: but if the Beast be upon the *Pale*, they say he is *Supported of the Pale*.

*Pallets* also is a Term which belongs to the *Ballance* of a Watch or Movement. See *Ballance*.

**PALLET** is a Room within the Hold of a Ship, closely parted from it, in which by laying some Pigs of Lead, &c. a Ship may be sufficiently ballasted, without loosing Room in the Hold; which therefore will serve for Stowing the more Goods.

**PALLET**, [with *Painters*] a small oval Table of Wood or Ivory, very thin and smooth upon which the Painters place their Colours, to be ready for the Pencil.

**PALLET**, [with *Gilders*] an Instrument made of the Tail of a Squirrel, for taking up the Gold Leaves from off the Pillow, to apply and extend them to that, which is to be gilded.

**PALLIATION** of a Disease, or a *Palliative Cure*, is a Method which helps (as much as is possible) incurable Diseases by the Application of present Remedies.

**PALLIATIVE Judication** [in *Medicine*] is when the Symptoms of a Disease give too much Trouble and Danger to have the Cure deferr'd, till the Disease is remov'd on which they depend.

**PALLIER**, a Landing-Place in a Stair-Case or a Step, which being much broader than the others, serves to rest upon.

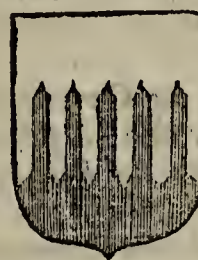
**PALLISADOES**, or *Pallisades* in Fortification, are strong Wooden sharp-pointed Stakes, six or seven Inches square, eight Foot long, of which three Foot is in the Ground, set up half a Foot

sometimes one above another, with a cross piece of Timber that binds them together. Some of these are also sometimes arm'd with two or three Iron-Spikes.

These *Pallisades* are usually fixed in the void Spaces without the *Glacis*, near the Bastions and Curtains; and in the Avenues of all such Posts as are liable to be surprized by the Enemy, or carried by Assault. Sometimes they are driven downright in the Ground, and sometimes stand at an acute Angle towards the Enemy; that if they should throw Cords about them to pull them up, they may slip off again.

*Pallisades* are always planted on the *Berne* of Bastions, and at the *Gorges* of half-Moons and other Out-works: They also *Pallisade* usually the Bottom of the Ditch; and to be sure, the *Parapet* of the *Covert-way*: And tho' sometimes they have placed these *Pallisades* three Foot from the said *Parapet* outwards towards the Campaign, yet of late they have been planted in the very middle of the *Covert-way*: All *Pallisades* should stand so close, as to admit between them only the Muzzle of a Musquet, or a Pike.

**PALLISADES turning**, are an Invention of Mr. *Coehorn's*, for in order to preserve the *Pallisades* of the *Parapet* from the Besieger's Shot; he orders them so, that as many of them as stand in the Length of a Rod, or in about 10 Foot, turn up and down like a Trap; so that they are not in Sight of the Enemy, but only just when they bring on their Attack; and yet are always ready to do the proper Service of *Pallisades*.



**PALLISE**, [in *Heraldry*] a Range of *Pallisades* before a Fortification, represented on a *Fesse*, rising up a considerable Height, with the Field appearing through them, as in the Figure annexed.

**PALLS**, *Pallia*, were Vestures made of Lambs Wool (25 H. 8. 20.) about 8 Fingers broad, with two Labels hanging down before and behind: These the Pope gives or sends to Archbishops and Metropolitans, who wear them about their Necks at the Altar above their Ornaments. We retain something of the Figure of it, in what the Heralds call a *Cross Pall*.

**PALM**, an antient long Measure among the *Romans* taken from the Palm of the Hand. The modern Palm is different according to the different Places where it obtains: At *Rome* it contains 7 Inches  $\frac{1}{2}$ , at *Naples*  $\frac{1}{2}$ , in *Languedoc* and other Parts of *France*, 8 Inches  $\frac{1}{2}$ , at *Morocco* and *Fez* 7 Inches  $\frac{1}{2}$ .

**PALMA**, [in *Anatomy*] the inside of the Hand 4.

**PALMARIS Longus**, is a Muscle of the Palm of the Hand, which has an Acute Beginning from the Internal Extuberance of the *Os Humeri*; and soon becoming a Fleishy Belly, and contracting it self again to a long, flat, slender Tendon, marches obliquely with the Tendon of the *Flexor Carpi superior*; and passing over the *Ligamentum Annulare*, where it expands it self, and cleaves firmly to the Skin of the Palm, is inserted to the Roots of the Fingers laterally; it being there divided to transmit the Tendons that bend them.

*Colum.*



*Columbus* observes the long Beginning of this Muscle, from the Extuberance of the *Os Humeri*, is sometimes wanting, which Observation is also confirmed by our Experience (saith Mr. *Cowper* :) It assists, in firmly grasping any Tactile Body, and defends the subjacent Tendons from external Injuries.

**PALMARIS Brevis**, is a Muscle of the Palm of the Hand, by *Spigelius*, called, *Caro Musculosa Quadrata*. Anatomists (saith *Cowper*) have been extremely deceived in their Ideas of this Muscle; it not arising from the *Membrana Carnosa*, as *Columbus* pretends, or from the eighth Bone of the *Carpus*, as *Fallopian* writes; but it springeth with a broad Membrane-like Tendon from the External Part of the *Os Metacarpi Minimi Digiti*, and one of the Bones of the *Carpus*; whence ascending over the *Abductor Minimi Digiti*, it becomes a thin disgregated Flethy Muscle, marching under the Tendinous Expansion of the former in the Palm; and is inserted by a short, strong Tendon, to the eighth Bone of the *Carpus*. This acting draws the *Mons Lunæ* towards the *Os Metacarpi Minimi Digiti*, whereby the Palm becomes hollow; contrary to the Opinion of *Spigelius*, who pretends it extends the Hand when we open it; which is not done by any proper Muscle, but by the common Extenders of the Fingers.

**PALMS**, [in *Botany*] white Buds, shooting out of Willows or Sallows before the Leaf, of the Expansions of which the Leaves themselves are formed.

**PALMUS**, [πάλλω of παλλω Gr. to agitate] is a Shivering or Palpitation of the Heart, caused by a Convulsion, or Irritation of the Nerves. *Blanchard*.

**PALPEBRÆ** are the *Eye-Lids*, or Coverings of the Eyes; they consist outwardly of a very thin Skin; inwardly they are lined with the *Pericranium*, which is here most thin and smooth; and between these two, is the *Membrana Carnosa*, which is also very thin.

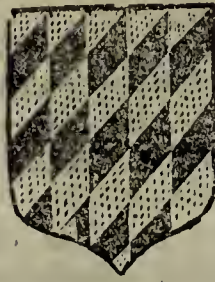
*Steno* observed several *Puncta Lacrymalia* in the Inner Membrane, which run on each Side into one Duct (which he calls *Collicia*) whereby the superfluous Moisture of the Eye-lids is conveyed into the Nostrils. At their Edges they have little soft Cartilages called *Cilia*, which serve to strengthen them, and to make them meet and close the more exactly. Their Corners are called *Canthi*, the outer and lesser of which hath a Gland in it called *Innominata*, which might well be called *Lachrymalis*, because it supplies most of the Matter of the Tears.

**PALPITATION of the Heart**, when Natural is in the Systole thereof; whilst the Cone and the Sides are pressed together, the Basis and the Roots of the Vessels being blown up with the Blood that gathers there, grows big and swollen. But it oft also proceeds from an extraordinary Contraction of the Heart, or a thick and irritating Matter which sticks in the Heart; and this is a Disease and preternatural. *Blanchard*.

**PALSEY**. See *Paralysis*.

**PALY**, when an Eschutcheon is divided into 6, 8, 10 Even Divisions *Pale-wise*; 'tis always Blazon'd, *Paly* of 6, 8, or 10, &c. *Pieces*; but if the Number be odd, then the Field is first named, and the Number of the *Pales* specified.

The like is to be understood also of *Barry* and *Bendy*.



**PALY Bendy**, is when a Coat is divided both *Pale* and *Bend-wise*, as here.

The Field *Paly Bendy Topaz* and *Diamond*, *Guillim*. p. 279.

**PANACEA**, [πανακία Gr.] was anciently a Name given by *Galen* to some Medicines which he had a great Opinion of: After, by the Chymists, it was the Term for their boasted *Universal Medicine*, which they pretended would cure all Diseases in all Circumstances, Ages, and Constitutions. There are several *Panacea*'s whose Preparation you will find in Books of Chymistry and Pharmacy; as that of Mercury, of Antimony, &c. which perhaps may be good Medicines in many Cases, but do all fall short of the Character of being *Universal Medicines*, and indeed it seems impossible there can be any such thing. The Word *Panacea* comes from the *Greek*, πᾶν and ἀνέομαι, *omnia sano*. There is also a Plant of this Name.

**PAMPINIFORME Corpus** [in *Anatomy*] a Kind of *Plexus* or Knot of Blood Vessels, formed by the Spermatick Veins, which constitute a Body call'd *Corpus Cavernosum pampiniforme* in their Progress through the Testes.

**PANARIS**, [in *Chirurgery*] a painful Tumour or Inflammation arising on the Extremities of the Fingers or Toes, vulgarly called a *Whitloe*.

**PANCHRESTON** πάνχρεστον of πᾶν all and χρεστός Gr. *useful*] a *Panacea*, or Remedy for all Distempers.

**PANARITIUM**, *Vid. Paronychia*.

**PANCHYMAGOGES**, [of πᾶν all and χεῖρας Tumour and ἄγωγος Gr. a *Leader*] are universal Medicines that expel all Kinds of Humours; according to the ancient Way of Expression.

**PANCREAS**, [πᾶνχρεας of πᾶν all and χρεῖας Gr. *Flesh*.] the Sweet-bread, *Pancration*, *Pancreon*, *Callicreas*, *Callicreon*, and *Lactes*, are all Synonymous. It is a conglomerated Glandule in the *Abdomen*, compacted out of many Globules, or Knots of Glands included in a common Membrane which it hath from the *Peritonæum*; these Globules are joined to one another, partly by Membranes, and partly by Vessels. It is placed behind the *Ventricle*, and fastened to the Gut *Duodenum*, and reaches from the Cavity of the Liver cross the *Abdomen*, to the lower End of the Spleen: By its Duct it is annexed to the *Duodenum*, and sometimes to the *Porus Bilius*, to the *Rami Splenici*, the *Caul*, the upper-part of the *Mesentery*, and the upper Nervous *Plexus* of the *Abdomen*; the Use and Office thereof, is to convey a Volatile, insipid, and Lymphatick Juice, or as others will have it (for it is a disputable Point) a something acid Juice, by its own Ductus to the Gut *Duodenum*, in order to a farther Fermentation and Volatilization of the Chyle, and to temperate and allay the Qualities of the Gall. It is the biggest Glandule in the whole Body, but bigger in a Dog than a Man.

Its Vessels are of five Kinds; for it hath Veins from



from the *Ramus Splenicus*; Arteries from the Left Branch of the *Cœliaca*, and sometimes from the *Splénica*. Nerves it receives from the Intercoſtal Pair, eſpecially from the upper *Plexus* of the *Abdomen*. It hath alſo many *Lymphatick* Veſſels, which paſs as the reſt do, to the common Receptacle of the Chyle. Beſides which it hath a proper Duct of its own, which is ſometimes called *Ductus Wirtſungianus*, becauſe found out by one *Wirtſungianus* at *Padua*, about 50 Years ago, but we uſually call it the *Pancreatick Duct*: This Veſſel hath uſually but one Trunk, whoſe Orifice opens into the lower End of the *Duodenum*, or Beginning of the *Jejunum*, and ſometimes is joined to the *Ductus Biliarius*, which with it makes but one Mouth into the Inteſtine; within the *Pancreas* (ſaith *Wharton*) it is divided into two Branches, which ſend forth Abundance of little Twigs into all the Globules, of which the Subſtance of the *Pancreas* is compoſed, where they imbibe the Humour that is ſeparated by them from the Arteries, and by their Trunk tranſmit to the Guts. The Pancreatick Juice is never found in this Duct, any more than Urine is found in the *Ureters*, by Reaſon of the Swiftneſs of its Motion, and the Steepneſs of the Way.

**PANCREATICK Juice** [in *Medicine*] an inſpid, Limpid Juice, or Humour, which is ſeparated from the Blood, and prepared in the *Pancreas*.

**PANEALEA**, as the modern Phyſicians call it, the ſame with a ſolid Electuary, but that it remains *intire*; for the Sugar being rightly boiled, is let grow hard: The Patient takes a Piece of it like a Lambitive. It only differs from Rolls and Morſels as to its Shape. *Blanchard*.

**PANDEMUS**, [of *πᾶνμος* invading the whole People] (*ſc. Morbus*) is a Diſeaſe which is univerſally riſe in any Place.

**PANDICULATION**, is the Reſtleſſneſs, Stretching and Uneaſineſs that uſually accompanies the cold Fit of an Intermitting Fever: 'Tis ſuppoſed to be occaſioned by a Convulſive Dilatation of the Muſcles, by which Nature endeavours to throw off ſomething that is diſagreeable to them.

**PANICULA**, is a Term in *Botany* for a kind of ſoft Woolly Beard or String, on which the Seeds of ſome Plants do hang pendulous, as in *Reeds*, *Millet*, &c. It ſignifies the ſame with *Juba*, and is oppoſed to *Spica*.

**PANIS fortis & durus**. See *Paine fort & dure*.

**PANNAGE**, *Pannagium*; ſignified formerly both the running and feeding of Hogs within a Foreſt, and alſo the Price that was paid for their ſo running. *Pannagium Liberum*, or *Free Pannage*, was a Liberty of free running for Swine within the Limits of ſuch Foreſts or Woods; and was ſometimes a Privilege granted to ſome private Perſons, and to ſeveral Religious Houſes. If this Pannage were not duly paid, there was a *Proceſs* from the *Exchequer* and a *Deſtraint* by the *Sheriff*. The Title of *Pannage* was ſometimes alienated from the *Parish* *Priest* to the *Appropriators*. *Dr. Keunet's Paroch. Antig.*

**PANNEL**, [in *Joinery*] a Tympanum or Square Piece of thin Wood fram'd or groov'd in a larger Piece between 2 Moulans, or upright Pieces, and two croſs Pieces or Traverſes.

**PANNEL**, [in *Masonry*] one of the Faces of a hewn Stone.

**PANNICULUS Carnoſus** is a flat ſort of Membrane in ſome Part thick and muſculous; in other parts thin with many *Ductus's* of Fat in it: It covers the whole Body.

**PANSELENE**, ſignifies the *Full Moon*.

**PANUS**, is a Sort of Botch or Sore under the Arm-pits, Jaws, Ears, and Groins; to wit, in the Glandulous Parts. It is alſo taken for *Phygethus*.

**PAPER-Office**. All the Acts of the Council-board, occaſional Proclamations, Diſpatches and Inſtructions for Foreign Miniſters, Letters of Intelligence, and many other Publick Papers communicated to the King's Council, or the two Secretaries of State, are afterwards tranſmitted to the *Paper-Office*, wherein they are all diſpoſed in a Place of good Security and Convenience within the King's Royal Palace.

Alſo an Office ſo called belonging to the King's Bench.

**PAPILIONACEOUS**, [of *Papillo* a *Butterfly*] Flower of a Plant; is by the Botanists accounted ſuch an one as repreſents ſomething of the Figure of a *Butter-fly* with its Wings diſplayed: and here the *Petala*, or Flower-Leaves, are always of a very Difform Figure. They are Four in Number, but joined together at the Extremities, wherefore they are rather *Monopetalous*, than truly *Tetrapetalous*. One of theſe four Leaves is uſually larger than the reſt, and is erected in the middle of the Flower, and by ſome called *Vexillum* and *Clypeus*. The Plants that have this Flower, are of the Leguminous Kind, as *Peaſe*, *Vetches*, &c.

**PAPILLA**, or the Nipple, is a red Excreſcy in the middle of each Breaſt, in the Pores whereof are received all the Milky Tubes or Pipes, proceeding from the Glandules of the Breaſt: It is of a ſpongy Subſtance, and cover'd with a very thin Skin: It is of exquisite Senſe, that both the Infant's Month in Sucking, and the Trickling of the Milk through it, may affect the Nurſe with Pleaſure in Suckling the Child.

**PAPILLÆ** of the Tongue [*Anatomy*] are little Eminences of the Tongue, ſo called, from the Reſemblance they bear to the *Papillæ* of the Breaſt.

**PAPILLÆ** [in *Anatomy*] the *Caruncula papillares* of the Kidneys are Bundles of ſmall Urinary Pipes joined together in the inner Subſtance of the Kidneys.

**PAPILLÆ Intestinorum**, are little Glandules, wherewith the Innermoſt Tunick of the Inteſtines or Guts is full: They ſoak in the percolated Chyle, and diſpenſe it to the Lacteal Veins. *Pecquet* calls this Lining of the Guts, a *Spongy Peristoma*; and *Bilſus*, a *Woolly Moſs*. 'Tis probable alſo that theſe *Papillæ* hinder the Excoriation of the Inteſtines. *Willis* takes them for a diſtinct Coat, and calls it *Glanduloſa*, and *Villoſa Tunica Intestinorum*.

**PAPILLÆ Parymidales**, are the Extremities of all the Nerves of the Skin, and ſerve more immediately for the Senſe of Feeling and Touching; about them there is a Web of Nerves and other Veſſels all covered with a Mucous Subſtance, to moiſten them and keep them in good Order. Under



der these *Papillæ Pyramidales* lie the *Glandulæ Miliæres*, which see. See also the Word *Skin*.

**PAPILLARY**, [in *Anatomy*] an Epithet applied to a Tunic or Membrane of the Tongue, that is the third Tegument plac'd beneath the Exterior Membrane which lines it, and the viscous Substance next under it.

**PAPILLARUM Processus**, or the *Processus Mammillares*, are the Extremities of the Olfactory Nerves, which convey the slimy viscous Humours by the Fibres, which perforate the *Os cribriforme*, to the Nostrils and Palate.

**PAPPOSE Herbs**. See *Pappus*.

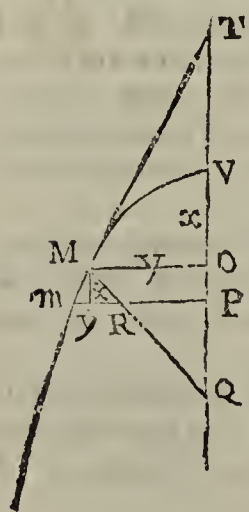
**PAPPUS**, in *Botany*, is that soft light Down which grows out of the Seeds of some Plants, such as *Thistles*, *Dandelion*, *Hewkweed*, &c. and which buoys them up so in the Air, that they can be blown any where by the Wind. And therefore this distinguishes one Kind of Plants, which is called *Papposa* or *Pappi Flora*.

**PAPULÆ**, the same with *Pustulæ*; also a Kind of *Small-Pox*: See *Exanthemata*.

**PAR**, in the Exchange of Money is a certain Number of the Pieces of the Coin of one Country, which contain in them an equal Quantity of Silver to that in another Number of Pieces of the Coin of another Country. v. g. Suppose 36 Shillings of *Holland* to have just as much Silver in them as 20 Shillings *English*; then Bills of Exchange drawn from *England* to *Holland* at the rate of 36 Shillings *Dutch* for each Pound Sterling is according to *Par*.

**PARABOLA**, [παράβολη Gr.] the Quotient in Geometrical Division, is called by this Name, by *Diaphantus* and others: The Reason of which see in *Division*.

**PARABOLA**. To draw a Tangent to the *Parabola* in a Point assigned.



Let the Point assigned be *M*, and the Parameter = *p*. Then the Equation expressing the Nature of the Curve is  $\boxed{px = yy}$

Suppose the Tangent found and all Things drawn as in the Figure.

'Tis required to determine the Subtangent *TO*; now the  $\Delta$ 's *m R M* and *M O T* being similar, let the former be noted with its proper Fluxionary Letters, and then this Proportion will arise.

$\dot{y} \cdot \dot{x} : : y \cdot \frac{\dot{x} y}{y} (= O T)$ . and the Equation of the Curve being  $\boxed{px = yy}$  the Fluxion ( $px = 2yy$ ).

and dividing all by *p*;  $\frac{2yy}{p} = \dot{x}$ . and substituting

$\frac{2yy}{p}$  instead of  $\dot{x}$ , in the Quantity  $\frac{\dot{x} y}{y} = O T$ , you

will find that  $\frac{2yy}{p} =$  is also equal to *O T*, then

substituting *px* instead of *yy*, you will have  $\frac{2xp}{p}$  or  $2x = O T$ : That is in the common *Parabola*.

The Subtangent is always = to twice the *Abscissa*.

*N. B.* In any *Parabola* if the Parameter be supposed = 1. and *m* be the Index of the Power of *y*, and a positive Number, whole or broken, then will  $\boxed{y^m = x}$  express the Nature of all *Parabola*'s

The Subtangent *TO* in the *Parabola* being equal to *2x*: and  $\square MO = (yy) = px$ . by Reason of the familiar Triangles *MOT* and *MOQ*:  $OT (=2x) \cdot y : : y \cdot \frac{y y}{2x} = O Q$ , and then putting

for *yy* its equal *px* it will be  $\frac{px}{2x} = O Q$  or  $\frac{p}{2} = O Q$

which gives you a very remarkable Property of the common *Parabola*: viz. That the Sub-normal, as the Line *O Q* is called, is always equal to half the Parameter of the Axis; and consequently a standing Quantity.

Wherefore 'tis a very ready Way to draw a Tangent to the *Parabola*, to set off half *p* from *O* the Foot of any Ordinate downwards in the Axis, and from *Q*, draw *M Q*: And to it at Right Angles *M T*: For that shall be the Tangent requir'd.

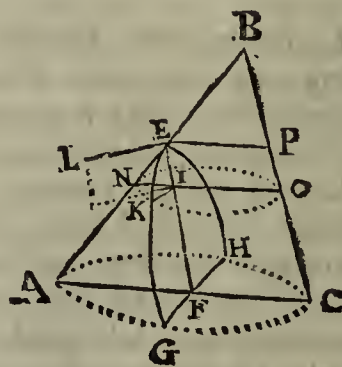
**PARABOLA**, is a *Conick Section* arising from a Cone's being cut by a Plane parallel to one of its Sides, or parallel to a Plane, that touches one Side of the Cone,

In any *Parabola*, *GKEH*, the Square of *IK*, the Ordinate *Applicate*, or *Semi-ordinate*, is equal to the Rectangle *IL*, under the *Latus Rectum* *EL*, and the *Abscissa*, or intercepted *Ax* *E I*.

## NOTATION.

Let the Side *AB* (of the Cone) be *a*, the Side *BC* = *b*, the Diameter of the Base *AC* = *c*: Let *EB* be called *o a*, and *E I* = *e b*.

Wherefore the Triangle *BCA* and *EIN* being similar, *BC* (or *b*) will be to *AC* (or *c*) : : as *E I* (= *e b*) is to *N I* a Fourth Proportional; which in this Notation will be  $\frac{e b c}{b}$ , or *e c*. Therefore *N I* = *e c*.



Also because the Triangles *ABC*, and *BEP*, are similar, *EP*, or its equal *IO*, will (this way) be found to be *o c*.

DEMON-



*Rectum*: For it multiplied into the *Abscissa*, makes *o o c c*, the Square of the Ordinate I K. And from this Equality between the Square and the Rectangle, *Apollonius* gave this Section the Name of the *Parabola*.

C O R O L L A R I E S.

I. Hence may the *Latus Rectum* be found very easily, if to  $b c$ , and  $o c$ , (that is to the *Side of the Cone*, parallel to the *Axis of the Section*, to the *Diameter of the Base*, and to the *Latus Primarium*) you find a Fourth Proportional; for that will be  $\frac{o c c}{b}$ , the *Parameter*, or *Latus Rectum* = E L.

II. And if you multiply the *Parameter*  $\frac{o \ c \ c}{b}$  both above and below the Line by  $a$  (the Side of the Cone in which is the Vertex of the Section) you will have this Quantity  $\frac{a \ o \ c \ c}{a \ b}$ ; which may easily be resolved into these Proportionals,

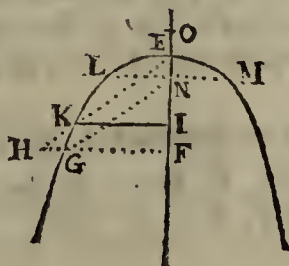
$$ab : cc :: ao : \frac{aocc}{ab}, \text{ i. e. } \frac{occ}{b}$$

Which gives *Apollonius* his Canon to find the *Latus Rectum*, (Lib. 1. Prop. 11. *Barrow*) and is in Words thus: *As the Rectangle under the Sides of the Cone is to the Square of the Diameter of the Base :: so is the Distance between the Vertices of the Cone and of the Section, to the Latus Rectum.*

III. *Praxis* 1, Hence if you have the *Vertex* and *Parameter* of any *Parabola*, 'tis easie to describe it on a Plane.

For draw a Right Line for the Axis, and in that take as many *Absciffæ* as you please; then find between them singly and the *Latus Rectum*, so many mean Proportionals, which if you rightly apply to the Axis will be *Semi-ordinates*; and, lastly, their Ends or Extreame neatly joined, shall give the Curve of the *Parabola*.

IV. *Praxis 2.* Having the Vertex and Ordinate, to find the *Parameter*, Geometrically,



Apply rightly the Semi-ordinate K I, and take from the Vertex O,  $EF = IK$ ; then through F, draw a Parallel (as HF) to the Ordinate IK, and produce OK to H; so will HF be the *Parameter* or *Latus Rectum* sought.

For the Triangles  $OKI$  and  $OHF$  being similar,  $EI : IK :: EF (= IK) : FH$ ; and consequently  $FH$  is a true *Parameter*.

V. And since the *Parameter* in this Way of Notation, is  $\frac{ccc}{b}$ , let it in the last Figure be applied to the *Parabola* in the Position L M. Then will N be the Point which is called the *Focus* of the *Parabola*: L N will be  $\frac{ccc}{2b}$ , and its Square  $\frac{oooo}{4bb}$ , which divided by the *Parameter*  $\frac{ccc}{b}$ , gives  $\frac{ccc}{4b}$  for the *Abscissa* E N: And shews that the *Focus* is always distant from the *Vertex* of the *Parabola* by  $\frac{1}{4}$  of the *Parameter*.

VI. *Prazis* 3. Having thus gained the *Focus*, the Curve of a *Parabola* may be described yet more easily and readily: If you draw first the Axis *O F* (*Fig. last*) and then an Ordinate in any Point, as *F*. After this take the *Ab-scissa* *O F* in your *Compasses*, and setting one Foot in the *Focus* *N*, cross the Ordinate in *G*, so shall the Point *G* be in the *Parabola*. And thus may as many Points as you will, be speedily found.

*The DEMONSTRATION of which  
Practice depends upon this.*

That E N being  $= \frac{0cc}{4b}$  for E F, put  $i b$ ;  
then shall N F  $= i b - \frac{0cc}{4b}$ , whose Square is  
 $i i b b - \frac{0ccc i}{2} + \frac{00cccc}{16bb}$ . To which if you  
add the Square of G F, which in this Way of  
Notation was above shewed to be  $oicc$ , then  
the Square of N G will  $i i b b + \frac{oicc}{2}$   
 $+ \frac{00cccc}{16bb}$ , whose Root in this Notation, will  
be  $i b + \frac{0cc}{4}$ . So that a Line drawn from  
the *Focus* to the End of the Ordinate will always  
be equal to the *Abscissa* E F + E N. That is,  
(supposing E O taken equal to E N) to the  
Line F O.

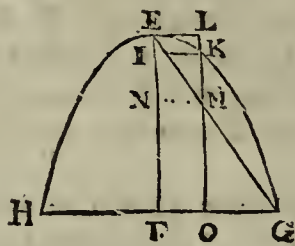
PROPOSITION II.

*In the Parabola E K G H, the Squares of the Ordinates are as the Abscissæ.*

I say,  $\square KI : \square GF :: EI : EF$ .

For





For let E F be called  $ib$ , as E I was before called  $ec$ : Then the Parameter being  $\frac{oc}{b}$  the Square of F G the Ordinate will be equal to the Parameter multiplied by  $ib$  the *Abfiffa*; that is  $= oicc$ : as before, the Square of K I was  $= oecc$ . But Rectangles having the same Bases, are as their Altitudes; wherefore these Rectangles will be as the *Abfiffæ*: And these Rectangles are  $=$  to the Squares of the Ordinates; wherefore the Squares of the Ordinates are as the *Abfiffæ*. Q. E. D.

C O R O L L A R R Y.

If a Line, as  $LO$ , be drawn parallel to the Diameter or Axis of the Section, and be cut by the Transverse Line  $EG$  in  $M$ , and by the Curve of the Parabola in  $K$ ; then shall  $OL$ ,  $ML$ , and  $KL$ , be in continual Proportion.

For the Triangles E F G and E N M being similar, and N M, parallel to F G, E F must be to E N :: as F G : N M (*i.e.* I K). But the Squares of G F and I K are in a *duplicate Ratio* of E F to E N, and yet are by this Proposition as the *Abscissæ* F E and E I; wherefore F E to I E, is in a *duplicate Ratio* of E F to E N; that is, E F : E N :: E N : E I. And by Construction of the Figure, it will be the same in L O, which is parallel to E F : that is, O L : M L :: M L : K L : or O L, M L, and K L are in continual Proportion. Q. E. D.

### PROPOSITION III.

*In the Parabola, the Parameter is to the Sum of any two Ordinates, as their Difference is to the Difference of the Abscissæ.*

I say,  $EL$  the Parameter, is to  $IK + \bar{F}G ::$  (see the last Figure) that is, to  $HO :: OG$  their Difference, is to  $IF$  (or  $KO$ ) the Difference of the *Abcissæ*.

Let E F the greater *Abfiffa* be called  $i b$ , and the leffer E I,  $e b$ . Then by *Prop. 1.* the Square of the Ordinate K I, will be  $o e c c$ , and consequently the Ordinate it self  $= \sqrt{o e c c}$ , fo alfo putting  $i$  instead of  $e$ ,  $\sqrt{o i c c}$  will be the Ordinate F G.

Having thus noted them, if you set the *Latus Rectum*, the Sum and Difference of the *Ordinates*, and the Difference of the *Abscissæ*, after the manner of four Terms, in disjunct Geometrical Proportion (as below) you will find the Rectangles of the Extreams and Means equal, and consequently the four Terms to be truly proportional.

Q. E. D. As,

Param.

$occ$ : Sum of the Ord. :: Diff. of the Ord. : D. Abf.  
 $b \cdot \sqrt{occ} + \sqrt{occ} :: \sqrt{occ} - \sqrt{occ} : ib - eb.$

And to avoid the Trouble of Multiplication in Surds, which is the Case of the two middle Terms you need only consider this *Theorem*: That the Sum of any two Quantities multiplied by their Difference, is equal to the Difference of their Squares. For so you will easily find, that the Product in both Cases, will be the same Quantity *o i c c*  
— *o e c c*.

N. B. This is that Property of the *Parabola* on which our famous Mr. *Baker* founded his *Clavis Geometria Catholica*, which was unknown to the Ancients, and communicated to him by Mr. *Tho. Strode* of *Maper-ton* in *Dorsetshire*: And by which he shews how to find the Value of the Unknown Root in all Equations, not exceeding *Biquadratics*.

See *Construction* and *Central Rule*.

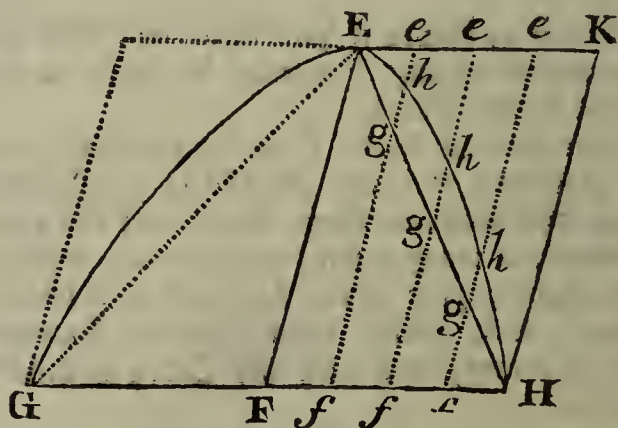
This Property of the *Parabola*, I thus briefly demonstrate in my *Algebra*, p. 78.

Let P be the Parameter of any *Parabola*, whose two *Ordinates* are O and o, and their respective *Abscissæ* A and a. Then I am to prove that P: O + o :: O — o, A — a. Which is clear; because from the first Property of the *Parabola*, PA = O O and P a = o o. Wherefore P A — P a = O O — o o, from the Nature of Equations. And that last, resolved into Proportionals, will stand thus,

$$P : O \vdash o :: O - o : A - a.$$

A PARABOLICK Space, is that Area contained between the Curve of the *Parabola* and any Entire Ordinate G H.

And this *Space* is to a *Parallelogram* circumscribed as 2, 3, and to a *Triangle* inscribed as 4, 3.



Let F H, the Semi-ordinate be divided into 4 = Parts, or into 8, 16, &c. and thro' the Divisions draw Lines, as *ef*, *ef*, &c. to parallel the Axis E F. Suppose also E F to be 4.

Then I say, The *Parabolick Space* E H F, is to the *Parallelogram* F K :: 2. 3. But to the  $\Delta$  E F H :: as 4. 3.



For, 1.  $gf, g f, g f, \&c.$  are in continual Arithmetical Proportion from the Nature of plain Triangles.

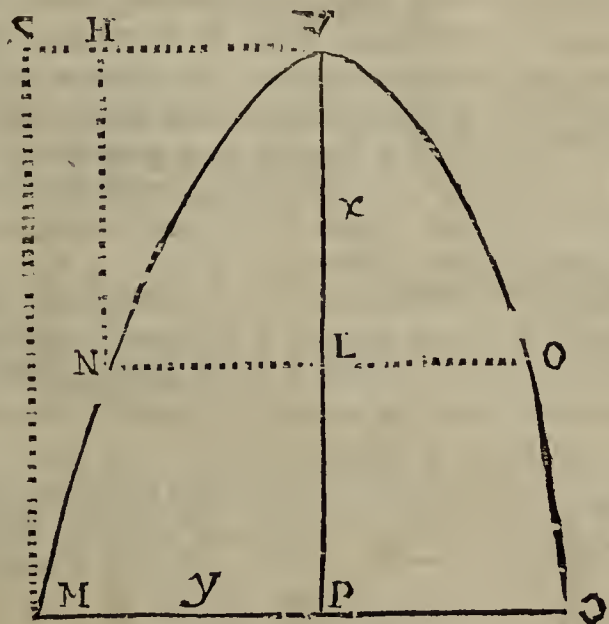
2.  $f e . g e :: g e . e h$ , (by Cor. 1. Prop. 2. of the Parabola.) But  $h e$  in the Axis  $E F = 0$ , and in the first Parallel  $e f$  must be equal to  $\frac{1}{4}$ : in the next  $e f$ , it will be equal to  $\frac{4}{4}$ ; in the third to  $\frac{9}{4}$ ; and so on in a Duplicate Arithmetical Progreffion. For as  $e f (= 4) . g e (= 1) :: f o$  is  $g e (= 1) . e h (= \frac{1}{4})$ . And as the second  $e f (= 4) . e g (= 2) :: e g 2$ , to  $e h = \frac{4}{4}$ , &c. And thus will it be if the Lines  $F f, f f, \&c.$  be again bisected, &c. *ad infinitum*. So that all the Indivisibles of the Trilinear Space  $E K H E$  will be a Duplicate Arithmetical Progreffion increasing. But

3. The Sum of a Rank of such Terms is subtriple to a Rank of as many equal to the greatest; (as we proved in N<sup>o</sup> 7. of *Arithmetical Progreffion*, which see) wherefore the whole Trilinear Space  $E K H E$  is to the Parallelogram :: as 1 to 3. And consequently the remaining Parabolick Space must be to it as 2 to 3. Q. E. D.

And Since the Triangle  $F E H$  is to the Parallelogram as 1 to 2, it must be to the Parabola as  $1 \frac{1}{2}$  to 2, or as 3 to 4. Q. E. D.

And this is a true and very short Quadrature of the Parabola of which *Archimedes* wrote so long ago, and many Geometricians have since expedited. 'Tis plain also that this Demonstration is Univerfal, and extends to any Parabolick Space.

The Quadrature of the Parabola, by the Method of Fluxions, I have formerly in my *Algebra* shewed to be very briefly thus



Let the Parameter be  $p = 1$ , the Abscissa be called  $x$ , and the Ordinate  $y$ .

Then by the first Property of the Parabola  $x = yy$ , because  $p = 1$ .

And consequently by the Extraction of the Roots of each, and using the new Notation,

$x^{\frac{1}{2}} = y$ . Then multiplying  $x$  by  $x$  the Fluxion of the Abscissa, it will stand thus  $x^{\frac{1}{2}} x^{\frac{1}{2}} =$

to the Fluxion of the Area. After which find the

Flowing Quantity answering to that Fluxion, which shall give the Area in known Terms.

To do which, the Fluxion being  $x^{\frac{1}{2}}$  first take away the  $x$ , and there will remain  $x^{\frac{1}{2}}$ ; next increase the Index of that Power by Unity, and it will stand thus  $x^{\frac{3}{2}}$ . Then divide  $x^{\frac{1}{2}}$  by  $1 + \frac{1}{2}$  or by  $\frac{3}{2}$  (thus  $\frac{3}{2}$ )  $\frac{x^{\frac{1}{2}}}{\frac{3}{2}} = \left( \frac{2 x^{\frac{1}{2}}}{3} \right)$  and the the Quotient you see will be  $\frac{2 x^{\frac{1}{2}}}{3}$ .

Lastly, instead of  $x^{\frac{1}{2}}$  substitute what was before found equal to it, viz.  $y$ , and it will be  $\frac{2 x y}{3} =$  to the Area of the Semi-parabola  $V M P$ .

And if you double that, you will gain the Area of the whole Parabola  $M V O$ .

Wherefore the Parabolick Area is Two thirds of a Rectangle under the Abscissa and the Ordinate. Q. E. D.

The following general Method for the Quadrature of all Manner of Parabolick Curves, is Mr. Humphrey Ditton's.

The General Equation of these Curves, is  $r^{\frac{p-q}{r}} x^q = y^p$ , where  $p$  and  $q$  are the Indexes, and  $r$  is the Latus Rectum: That is because of  $r$  a stable Quantity,  $x^q = y^p$ , wherefore in Fluxions  $p y^{\frac{p-1}{p}} y = q x^{\frac{q-1}{q}} x$ , and from the general Equation, it is  $y^{\frac{p-1}{p}} : x^{\frac{q-1}{q}}$  ::  $x : y$ , wherefore substituting  $x$  and  $y$ , instead of  $y^{\frac{p-1}{p}}$ , and  $x^{\frac{q-1}{q}}$  in the Fluxional Equation, we have  $p x y = q y x$ , but all  $x y =$  all  $S H M N =$  the Complement, and all  $y x =$  all  $P L M N =$  the Area: The Area therefore is to the Complement as  $p : q$ . Q. E. D.

PARABOLICK Spiral. See Helicoid Parabola.

PARABOLICK Pyramidoid, is a solid Figure so named by Dr. Wallis from its Genesis, or Formation, which is as follows.

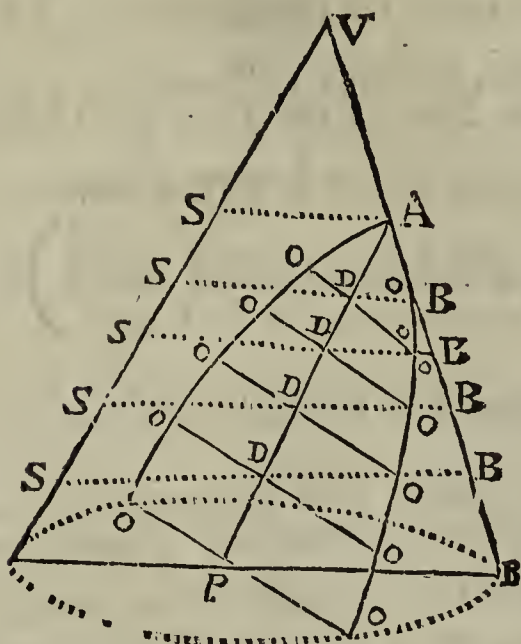
Let all the Squares of the Ordinate Applicates in the Parabola be imagined to be so placed, that the Axis shall pass thro' all their Centres at Right Angles.

Then will the Aggregate of these Planes, which he proves before to be Arithmetically Proportional (Prop. 9 Wallis Con. Sect.) form the Parabolick Pyramidoid.

Whose Solidity is gain'd by multiplying the Base by half the Altitude: The Reason of which is clear; for its component Planes being a Series of Arithmetical Proportionals beginning from 0, their Sum will be = to the Extreams multiplied by half the Number of Terms, i. e. in the present Case = to the Base multiplied by half the Height.



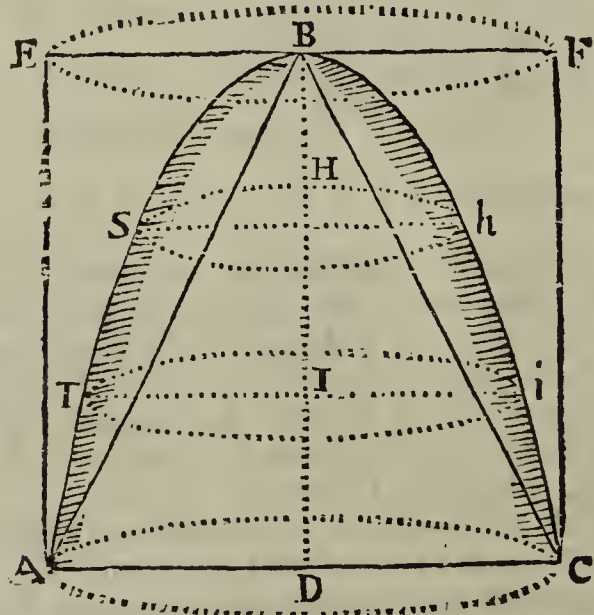
PARABOLICK *Cuneus*, is a Solid mentioned by the same Author, and formed thus:



Multiply all the  $DB$ 's into the  $DS$ 's, or which is the same thing, upon the Base  $APB$  erect a Prism, whose Altitude shall be  $AS$  or  $PS$ ; and this shall be the *Parabolical Cuneus*, which must of Necessity be equal to the *Pyrabolical Pyramidoid*; being all the Component Rectangles in one, are severally equal to all the Component Squares in the other.

PARABOLICK *Conoid*, is a solid Figure made by the Rotation of a *Semi-parabola* about its Axis, and is  $= \frac{1}{2}$  of its circumscribing Cylinder: And the Circles which may be conceived to be the Elements of this Figure, are in an Arithmetical Proportion decreasing towards the *Vortex*.

A PARABOLICK *Conoid*,  $ASB$   $h$   $C$ , is to a *Cylinder* of the same Base and Height, as 1 to 2; and to a *Cone* of the same Base and Height, as  $1 \frac{1}{2}$  to 1.



Let  $BD$  be divided into Three equal Parts; then  $\square AD : \square SH :: BD : BH$ , (by the second Property of the *Parabola*) that is, as 3 to 1, and  $\square AD : \square TI :: BD : BI :: 3 : 2$ . Wherefore 'tis plain, that the Squares on  $SH$ ,  $TI$  and  $AD$ , (as also on  $Sh$ ,  $Ti$ , and  $AC$ ) and the Circles answering to them, will be in Arithmetical Progression, or as 1, 2, 3; and thus it will be *ad Infinitum*, if the three Divisions be bisected, and those again bisected, &c. But a Rank of Numbers in single Arithmetical Progression, will be to a Rank of as many equal to the greatest as 1 to 2, and consequently, the

*Parabolick Conoid*, will be but just half the *Cylinder*. *Q. E. D.*

And a *Cone* being  $\frac{1}{3}$  of *Cylinder*, the *Conoid* will be  $= 1 \frac{1}{2}$  of it; and therefore *Cylinder Conoid*, and *Cone* will be as 3,  $1 \frac{1}{2}$ , 1.

PARABOLICK *Spindle*, is a solid Body made by Rotation of a *Semi-parabola* about its *Ordinate*; and is equal to  $\frac{8}{15}$  of its circumscribing *Cylinder*, *Cavalierius Exerc. Geometr.* p. 282.

PARABOLISMUS, the same with a *Depression of an Equation*. See *Equation*, N 3.

PARABOLOIDS, [of παραβολή and εἶδος Gr. *Form*] are Paraboliform Curves in Geometry; whose Ordinates are supposed to be in a Subtriplicate, Subquadruplicate, &c. Ratio of their respective *Abscissæ*; and putting  $x$  for the *Abscissa*,  $y$  for the *Ordinate*, and  $p$  for the *Parameter*, the Equation for the *Cubical Paraboloid* will be  $ppx = y^3$ . In the *Biquadrical Paraboloid*, the Cube of the *Parameter* into the *Abscissa* is equal to the *Biquadrate* of the *Ordinate*; that is  $p^3x = y^4$ : and so of other *Paraboloids ad infinitum*.

But there is also another Species of the *Paraboloids*; *v. gr.* 1. Suppose the *Parameter* multiplied into the *Square* of the *Abscissa* to be equal to the *Cube* of the *Ordinate*; that is,  $pxx = y^3$ . Then the Curve is called a *Semicubical Paraboloid*.

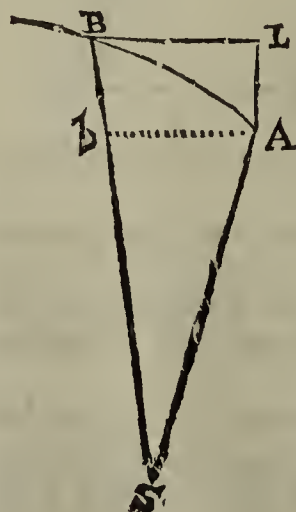
PARACELSISTICK Medicines. See *Hermetical*.

PARACENTESIS, [παρακέντησις Gr.] or *Punctio*, is a Perforation of the *Chest*, or *Abdomen*. It is made in the *Breast*, when that is stuffed with putrified Matter, or Water, and then the Perforation is made in the Side between the fifth and sixth *Vertebra*. It is made in the *Abdomen*, when that is swelled by a *Dropie*, and near the *Linea Alba*, in the *Muscles*, that either ascend right or oblique: In which last Case if a Man be strong, and has taken a *Purge*, and also his *Lungs*, and the rest of his *Entrails* be uncorrupted, when you see the *Navel* doth protuberate, there you must make the *Incision*; don't let *Purulency* and *Water* come out both together, for that were to kill the Patient, but one after the other: As in *Seven Days* about a *Pound*, or a *pound and a half*, as the Patient can endure it; after the Operation is finished, draw the *Wound* up with an *Astringent Plaister*. *Blanchard*.

PARACENTRICK, [of παρά and κέντρον Gr. a *Centre*] *Motion of Impetus*, is a Term in the new *Astronomy*, for so much as the *Revolving Planet* approaches nearer to, or recedes farther from the *Sun*, or *Centre of Attraction*.

Thus if a Planet in  $A$  move to  $B$ , then is  $SB$  —  $SA$   $bB$ , the *Paracentrick Motion* of that Planet. *Hayes. p. 293.*

PARACENTRICK *Solicitation of Gravity*, or *Levity* (which is all one with the *Vis Centripeta*) is in *Astronomy* expressed by the Line  $AL$  drawn from the Point  $A$  parallel to the Ray  $SB$  (infinitely near  $SA$ ) until it intersect the *Tangent*  $BL$ .



PARA-



PARACIUM, in Law, signifies the Tenure that is between *Paraceners*, viz. that which the youngest owes to the eldest.

PARCYNANCHE, [of *παρά* and *κυνάγχη* of *κύων* a Dog and *ἀγχω* Gr. to *strangle*] is an inflammation with a continual Fever and Difficulty of Breathing excited in the outward Muscles of the Larynx.

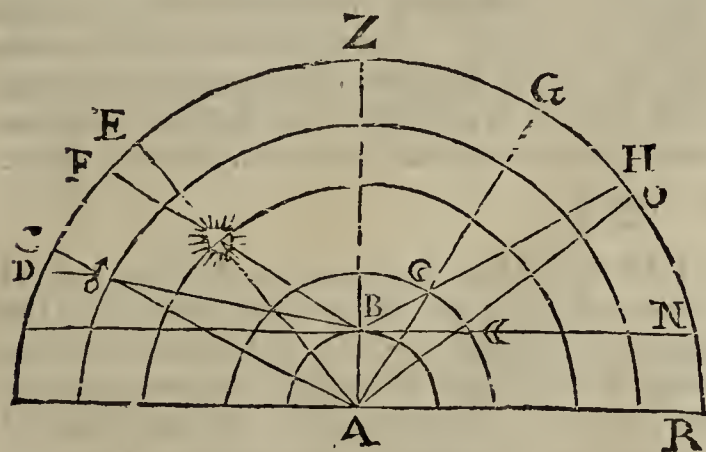
PARACMASTICA, [of *παραχυή* Gr.] is a daily declining Fever; also declining Age. *Blanchard*.

PARADE, is a military Word, signifying the Place where Troops usually draw together, in order to mount the Guards, or for any other Service.

PARADIGRAMMATICE, is the Art of making all Sorts of Figures in *Plaster*. The Artists in this are called *Gypsichi*.

PARAGORICKS, [*παραγορικοί* of *παραγορεύω* Gr. *I mitigate*] Medicines that mitigate or assuage Pain.

PARALLAX, [*παράλλαξις* of *παράλλω* to *vary alternately*] is that Arch of a great Circle, passing thro' the Zenith and true place of the Sun or Stars, and intercepted between the true and apparent place.



In this Figure,

A, denotes the Centre of the Earth.

B, the Place on the Superficies of the Earth, from whence the Star is seen.

♂, ☉, ♀, the Stars or Planets Places in their Orbs.

A ♂ C, A ☉ E, A ♀ G, the Lines of their true Places.

B ♂ D, B ☉ F, B ♀, the Lines of their apparent Places.

Here the Angle made by the Intersection of the said two Lines thro' the Body of the Planet, is the Angle of *Parallax*.

That is,

In *Mars* the Angle A ♂ B = Angle C ♂ D, (by 15 e. i.)

In the *Sun*, the Angle of *Parallax*, is the Angle A ☉ B = Angle E ☉ F.

In the *Moon*, it is the Angle A ♀ B = Angle G ♀ H.

Here 'tis manifest, that the nearer the Star is to the Horizon, and Center of the Earth, the greater is the *Parallax*: Whence it is, That the Orbit of the Moon being nearest to the Earth, her

*Parallax* is greatest and most perceptible: For the Semi-diameter of the Earth bears a greater Proportion to the Semi-diameter of the Moon's Orbit than to any of the rest.

The Horizontal Parallax of the Moon is the Difference between her Real and Apparent Place when she is either Rising or Setting. As suppose her Setting, then the Angle of the Horizontal Parallax will be B ♀ A = O A R. The Knowledge of the Quantity of which, is of the greatest Use in Astronomy; because from thence the Distance of the Moon, Sun, (or other Planet) from the Earth may most easily be had; for in the Triangle B A ♀: A B the Semi-diameter of the Earth, B the Right Angle, and ♀ the Angle of the Parallax being known, 'tis easie to find any Side or Angle sought, and consequently A ♀, the Distance of the Moon from the Earth. This came first to be discovered by the ancient Astronomers, thus:

They observed, That the apparent Semi-diurnal Motion of the Moon was but 4 Degrees, whereas in Reality and Truth, it was 6 Degrees: Wherefore they concluded, That the Moon's Place was put forward in her Rising 1 Degree, and as much put backwards in her Setting; which must needs cause her visible Motion above the Earth in 12 Hours, to be observed nearly 2 Degrees less, than the half of 12 Degrees, her apparent Motion in 24 Hours.

Wherefore from hence they concluded the Horizontal Parallax to be just 1 Degree: which having found, 'twas easie to discover, that A ♀ must be near 60 times A B, or 60 Semi-diameters of the Earth (*i. e.* at 70 Miles to a Degree, and 4000 Miles the Earth's Radius) 240000 Miles *English*.

*Mr. Auzout gives you a Method to find the Moon's Parallax, thus; On a Day when she is in her Perigee, or Apogee, and in the most Boreal Signs,*

Take her Diameter towards the Horizon, and then towards the South, with her Altitude above the Horizon; the Difference of which Diameters will shew the Proportion of her Distance with the Semi-diameter of the Earth; but this is best of all done in those places where she passes thro' the Zenith.

If the Moon's Horizontal Parallax could be truly and exactly found, it would be of prodigious Advantage; for by it the Longitude of places on Land (and tolerably well at Sea) might be discovered.

Captain *Halley* saith (at the End of his *Observations and Catalogue of the Southern Stars*), "That 'tis the Want of a true Knowledge of *Geometry*, which hath occasioned the Defects and Mistakes of Astronomers as to this Point."

He there gives three Ways to find the Moon's Parallax, which are nearly *Geometrical*, of which the first seems the best; and is thus:

Let two times of Observation be taken when the Sun is (nearly) equally distant from each Node of the Moon, and when the Moon also is to be Northerly in one Node, and Southerly in the other;



ther; in these things there needs no great Exactness, because the Differences of Latitude may be sufficiently supplied from the Tables.

At these times of Observation, let the visible Places of the Moon, both in Longitude and Latitude be taken together with her visible Altitudes and Diameters, which let be reduced to the Horizontal; then from the times and visible Places, let in each Observation the Vertical Angle be computed, which is made with the Circle of Latitude at the Moon's Centre; and then the Difference by which the Southern Latitude exceeds the Northern (in our Northern Part of the World) is the Sum of the Parallaxes of Latitude, which must be divided into two Parts; which to do, put into one Sum the Logarithms of the Sine of the Horizontal Semi-Diameter of the visible Distance of the Moon from the Vertex, and the Complement of the Angle of the Vertical Circle, with the Cycle of the Latitude, in each Observation.

Then out of the greater Sum, take the lesser, and to the Difference add Radius, the Sum shall be the Logarithm of the Tangent of an Ark, from whence take 45 Degrees: Then will it be as Radius to the Tangent of the remaining Ark :: So is the Tangent half of the Sum of the Parallax, to the Tangent of half their Difference: But the half Sum and half Difference together, is the greater Parallax of Latitude, and the Difference between them is the lesser. Take this Parallax of Latitude out of the visible Southern Latitude; or add it to the Northern, and it will shew the *Inclination*.

And then lastly, it will be as the Rectangle under the Sines of the Distance seen from the Zenith. and of the Complement of the Angle of the Vertical Circle with the Circle of Latitude, is to the Square of the Radius :: So is the Sine of the Parallax of Latitude, to the Sine of the Horizontal Parallax.

And there is between the Sine of the Horizontal Semi-diameter of the Moon, and the Horizontal Parallax, so constant a Proportion that if it can be but once known, the Moon's Parallax at any time will be had from the Observation of her Diameter.

All the Difficulty of this Process, is, in observing the visible Latitudes of the Moon, and which indeed cannot be had without the Help of the fixed Stars, whose Latitudes are in no Catalogue yet extant, correct to a Minute: Therefore the accurate Solution of this Problem must depend, on some better Tables than are yet published. And those I hope we may expect from the most Accurate Astronomer, Mr. *Flamsteed*, when he hath finished his Catalogue of the fixed Stars, which he is now about.

In the ingenious Dr. *Gregory's Astronomia Physica & Geometrica*, you have a great and very useful Variety of Propositions for the finding the Parallax, *Vide Lib. 2. Sect. 7.*

Though there be no Parallax of the Fixed Stars, in respect of the Earth's Semi-diameter, the whole Body of the Earth being but a Point in reference to the distance between us and the Fixed Stars; yet in respect of the annual Orbit of the Earth, it hath justly been expected by Astronomers, that some Parallax should be found: And this would be a Discovery of great Moment, if it could be

made; because it would be an undoubted Demonstration for the annual Motion of the Earth round the Sun, if any such Parallax could be discovered.

This the ingenious Dr. *Hook* attempted to find by observing the various Distance of a fixed Star from the Zenith (see a Dissertation of his designedly written on this Subject). And our excellent Astronomer Mr. *Flamsteed*, actually did observe it by the Access and Recess of a Fixed Star to and from the Pole of the Equator at different times of the Year.

And he assures us, in his Letter to Dr. *Wallis*, written *Decemb. 20. 1698*, and published in the *Latin Edition of Dr. Wallis's Works*: "That he found the Distance of a Fixed Star near the Pole of the World to be 40 Seconds, or 45 Seconds nearer to it at the Winter-Solstice than at the Summer one." And this he observed for Seven Years together with great Accuracy.

So that he judges the Objection of *Ricciolus* against the Earth's Motion to be entirely removed, and its Revolution round the Sun proved.

Dr. *Gregory* seems not satisfied with this Proof, (though he believes the Doctrine from other Principles) but inclines rather to the Opinion of *Copernicus*, That the Diameter of the Earth's annual Orbit is insensible, in respect of the Distance of the Fixed Stars. But others may judge whether he brings Reasons sufficient to overthrow Observations so carefully, and so often made, as those produced by Mr. *Flamsteed*. See his *Astron.* p. 275, 276.

**PARALLAX of Latitude**, an Arch of a great Circle passing by the Poles of the Zodiack to the apparent Place of the Star, and intercepted between two Circles of the Ecliptick equally distant, whereof the one passeth by the true Place of the Star, and the other by the apparent Place.

**PARALLAX of Longitude** is an Arch of the Ecliptick (or Parallel thereto) intercepted between two great Circles, whereof the one passeth from the Poles of the Ecliptick, and the true Place; the other from the said Poles by the apparent Place: So that the Parallax of Longitude is only the Difference of the true apparent Place according to the Longitude of the Ecliptick.

**PARALLAX**, in the *Leipsick Acts for October 1685*, there is an Account of the *Cassian Method* of finding the *Parallaxes* and *Distances* of the *Planets* from the Earth; practised at *Rome* by the Abbot *Fran. Blanchinus*.

**PARALLAX Diurnal** of the Sun. How to find it, see under *Sun* in this Vol.

**PARALLAX of Ascension and Descension** [is an Arch of the Equator, whereby the Parallax of the Altitude increases or diminishes the Longitude.

**PARALLAX of Declination** [*Astronomy*] is an Arch of a Circle of Declination, whereby the Parallax of the Altitude increases or diminishes the Declination of a Star.

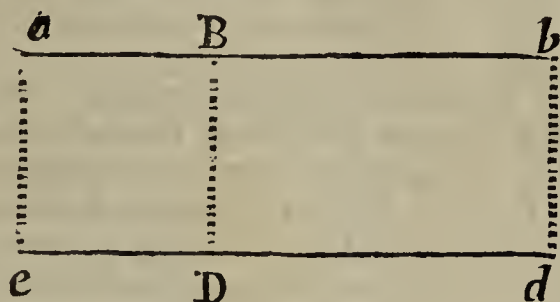
**PARALLAX** [in *Levelling*] is the Angle contained between the Line of the true Level, and the Line of the apparent Level.

**PARALLACTICAL Angle**, is an Angle made by the oblique cutting of a Circle of Altitude, or Vertical Circle with the Ecliptick. How to find it, see *Angle of the Ecliptick with the Vertical Circle*.

PARALLEL



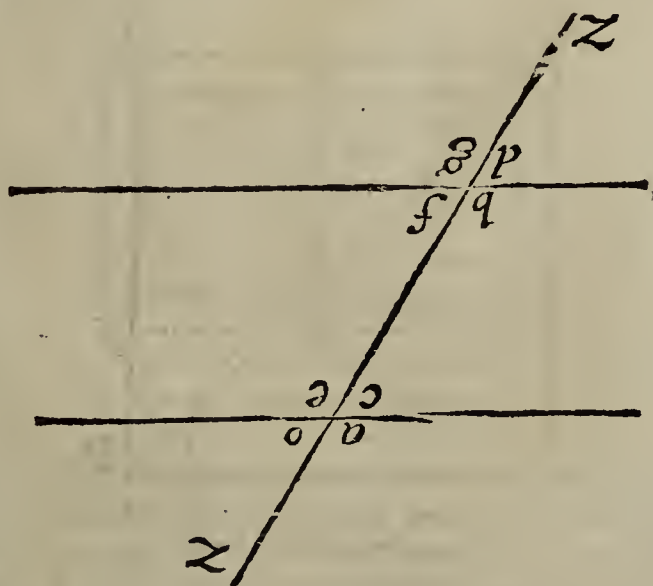
**PARALLEL Lines**, in Geometry, are those which run always equi-distant from each other; so that if they were infinitely produced, they would neither go further from, nor come nearer to each other; and their Distance is always measured by a Perpendicular, which, where-ever it be taken, is of the same Length, or is always equal to it self.



Thus the two Lines,  $ab$  and  $de$ , are *Parallel*, if they are equally distant from each other in  $a$ ,  $e$ ,  $B$ ,  $D$ ,  $b$ ,  $d$ , and in all other Places.

### COROLLARY I.

*Parallel Lines*  $Pp$ , have the same Inclination one as the other, to any Right Line as  $ZZ$ , which cuts or crosseth them both, and consequently (since an Angle is the mutual Inclination of two Lines which meet in a Point) the *External Angle*  $o$  or  $a$ , must be equal to the *Internal and opposite One*,  $f$  or  $b$ : that is,  $o=f$ , and  $a=b$ .



For if  $o$  be not equal to  $f$ , and  $a$  not equal to  $b$ , it must be because the upper Parallel  $P$ , is either more or less inclined to  $ZZ$ , than the lower Parallel  $p$  is; which if true, then the Line cannot be parallel; which contradicts the Supposition.

### PROPOSITION.

A Right Line  $ZZ$  falling on two Parallel Lines  $Pp$ , makes the alternate Angles  $o=f$ , and  $e=b$ ; also  $o=d$ , and  $a=g$ , and the two Internal Angles  $c+b$ , or  $e+f$  = to two Right ones.

That is,  $\left\{ \begin{array}{l} 1 \ c=f \\ 2 \ e=b \\ 3 \ o=d \\ 4 \ a=g \end{array} \right\}$  and  $\left\{ \begin{array}{l} 5 \ c+b \\ 6 \ e+f \end{array} \right\} = 2 \text{ L.}$

### DEMONSTRATION.

1.  $c=f$ , because  $c=o$ , its Vertical or opposite Angle, and  $o=f$ , by the precedent Corollary.

2.  $e=b$ , because  $=$  to  $a$ , which is  $=b$ , proved the same way.

3.  $o=d$ , because  $=c$ ,  $=f$ ,  $=d$ .

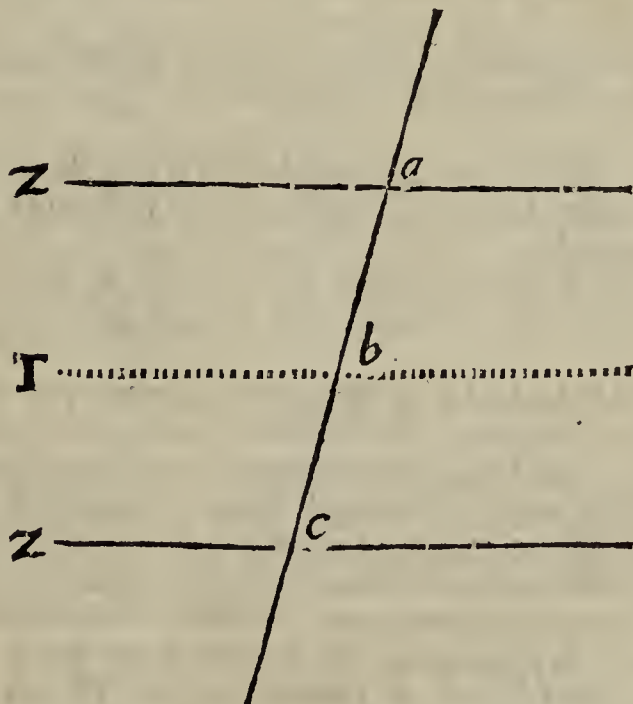
4.  $a=g$ , because  $=e$ ,  $=b$ ,  $=g$ .

5.  $e+b = 2 \text{ L}$ , because  $b+f = 2 \text{ L}$ , (by 13  $\text{e } 1$  Euclid.) and  $f=c$  by Step. 1. Wherefore  $c+b = 2 \text{ L}$ .

6.  $e+f = 2 \text{ L}$ , because  $f+b = 2 \text{ L}$ , (by 13  $\text{e } 1$ ) and  $e=b$  (by Step. 2.) Wherefore  $e+f = 2 \text{ L}$ . See the last Figure.

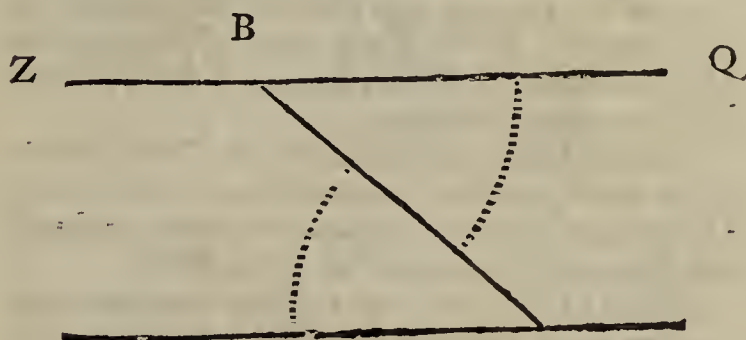
### COROLLARY II.

Two Right Lines as  $ZZ$ , parallel to a Third, as  $T$ , are parallel to each other. For since the Angle  $a=b$ , and  $c$  also  $=b$ , because the Outer Lines are parallel to the inner one: Therefore the Angle  $a=c$ , i. e. the two outer Lines, are also parallel by Cor. 1.



### PROBLEM I.

A Right Line, as  $ZQ$ , being given, to draw another parallel to it, thro' A, a given Point.



From A draw a Line making any Angle, as  $ABQ$ , with the given Line; then setting one Foot of the Compasses in A, make the Angle  $BAC = ABQ$ , so shall  $CAO$  be the Line required, for the Angle A is  $=$  to the Alternate one B.

**PARALLEL Sphere**, is where the Poles are in the Zenith and Nadir, and the Equator in the



Horizon, which is the Cafe of fuch (if any fuch there be) who live directly under the North and South Pole.

The Confequences of this Pofition are, That the Parallels of the Sun's Declination will alfo be Parallels of his Altitude.

The Inhabitants can fee only fuch Stars as are on their Side the Equinoctial; and they muft have fix Months Day, and fix Months a continual Night every Year; and the Sun can never be higher with them, than 23 Degrees 30 Minutes, which is not fo high as he is with us in *February*.

PARALLEL Ruler, is an Instrument made of Brafs, Steel, or Wood, to draw Lines parallel to each other; of great Ufe in Fortification, Architecture, and many other Parts of the *Mathe-maticks*.

PARALLEL Sailing in Navigation, is failing under a Parallel of Latitude: of this there are but 3 Cafes. 1. Given Departure and Distance. Required Latitude.

The Canon is, As Diff. of Longitude to Rad. :: fo is Distance to Cofine of the Latitude.

2. Given Diff. of Longitude between two places under the fame Parallel; required their Distance.

The Canon is, As Rad. to Diff. Longitude :: fo is the Cofine of Lat. to Distance.

3. Having the Distance between two Places in the fame Latitude, required their Difference of Longitude.

The Canon is, As the Co-fine of Lat. to Distance :: fo is Rad. to Diff. Longitude.

PARALLELS of Altitudes, or *Almacanters*, are Circles parallel to the Horizon, imagined to pafs thro' every Degree and Minute of the Meridian, between the Horizon and Zenith, having their Poles in the Zenith. And on the *Globes* these are defcribed by the Divisions on the *Quadrant of Altitude*, in its Motion about the Body of the Globe, when 'tis screwed to the Zenith of any Place.

PARALLELS of Latitude, on the *Terrestrial Globes*, are the fame with *Parallels of Declination* on the *Celestial*. But the

PARALLELS of Latitude on the *Celestial Globes*, are small Circles parallel to the *Ecliptick*, imagined to pafs through every Degree and Minute of the *Colures*, and are represented there by the Divisions of the *Quadrant of Altitude*, in its Motion round the Globe, when it is screwed over the *Poles of the Ecliptick*.

PARALLELS of Declination, are Circles parallel to the *Equinoctial*, imagined to pafs thro' every Degree and Minute of the Meridians, between the *Equinoctial* and each *Pole of the World*.

PARALLEL Rays, in *Opticks*, are thofe that keep an equal Distance from the vifible Object to the Eye, which is fuppofed to be infinitely remote from the Object.

PARALLEL Planes, are thofe Planes which have all the Perpendiculars drawn betwixt them equal to each other; that is, when they are every where equally diftant.

PARALLEL Circles on the *Globes*, the fame with the *Leffer Circles*.

PARALLELS alfo on the *Terrestrial Globe*, are

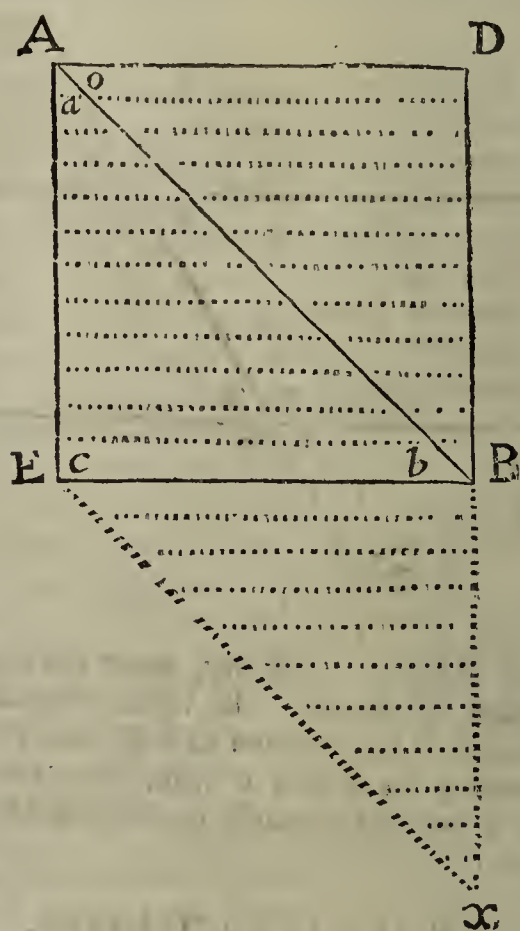
Circles drawn thro' the middle of every *Climate*, dividing them into two Halves, which are called *Parallels*.

PARALLELISM [*παράλληλισμός* Gr.] of the Earth's Axis, is the Earth's keeping its Axis in its annual Revolution round the Sun, in a Pofition always parallel to it felf, which it doth nearly, but not exactly; for tho' the Difference be infenfible in one Year, Dr. *Gregory* in his *Affronomy* faith, It becomes fenfible enough in many Years.

This *Parallelism* he fhews to be the neceffary Refult of the two Motions of the Earth, that is, round its Axis, and its Annual one, and that there needs no third Motion be feigned to explain it, or account for it: For as the Earth moves Annually round the Sun (without the Diurnal Motion) it moves only according to its Centre of Gravity; and each Point and Line in it keeps always the fame Pofition. Let its Axis be one of thofe Lines; the Diurnal Revolution of the Earth round this (which as to that Motion is fuppofed immoveable) cannot change the Pofition of it; and therefore it will be always the fame, *i. e.* always Parallel to it felf.

PARALLELOGRAM, [*παράλληλόγραμμο* Gr.] in *Geometry* is a Right Lined Quadrilateral Figure, whose oppofite Sides are Parallel and Equal. To find its superficial Content: See *Area*.

The Formation, or Generation of all Parallelograms, Squares and Rectangles, may be thus conceived.



If a Right Line, as A D, having one of its Ends or points in the Top (or Vertex A) of the Angle E A B, be fuppofed to move downwards, with a Motion always Parallel to it felf in its firft fituation: And as it moves thus, always keep its faid End A in the Line A E; till at laft it be moved down fo low, as that it is all of it gotten within the Legs of the Angle, and is come to lie in the Situation E B: 'Tis plain, this Line A D will by its Motion downwards have defcribed the

Quadri-



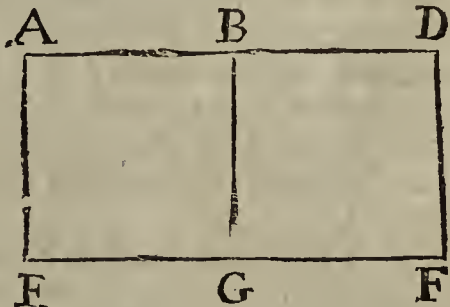
Quadrilateral Figure A D B E. And as in its Descent, the Line A D continually cuts the Line A B, so it will describe also on each side of A B the two equal Triangles A D B and A E B. The Parts of the former of which, do continually decrease, as those of the latter A E B do increase.

Also, if either Leg of an Angle E A D, as suppose the Leg A D, or any part of that Leg A B, be conceived to move along the other A E, with a Motion Parallel to its first Situation, it will also describe a Quadrilateral Figure, which if the *Describent* Line A B, be equal to the *Dirigent* A E, (for so those two Lines may be called) will be an Equilateral one. But when the *Dirigent* is either longer or shorter than the *Describent* Line, then the opposite Sides of the Figure only will be equal.

From which Formation of Quadrangles, (and also of Triangles) these Corollaries may be deduced.

### COROLLARY I.

That all Quadrilateral Figures thus formed, must also be *Parallelograms*, or have their opposite Sides equal and parallel. The Reason of which is because the Moving Line, or *Describent* A D is always supposed to be carried Parallel to it self; and the Distance between A and D, or A and B the *Describent* Points, are always the same. 33. *è 1.*



### COROLLARY II.

Since the Angles A and E are together equal to two Right Angles, if one be a Right Angle, the other must be so also; and then all the Angles of the Figure will be Right ones, and so 'twill be a Rectangle as A F; and if the *Describent* be equal to the *Dirigent*, the Figure will be a Square, as A G. *Cor. 29. è 1 Eucl.*

Hence also 'tis plain, That the Opposite Angles of every *Parallelogram* are equal; because they do each of them, with the Angle between them, make two Right Angles.

### COROLLARY III.

Whence it appears, That every Diagonal A B, divides the *Parallelogram* into two equal Parts. 34 *è. 1 Eucl.*

### COROLLARY IV.

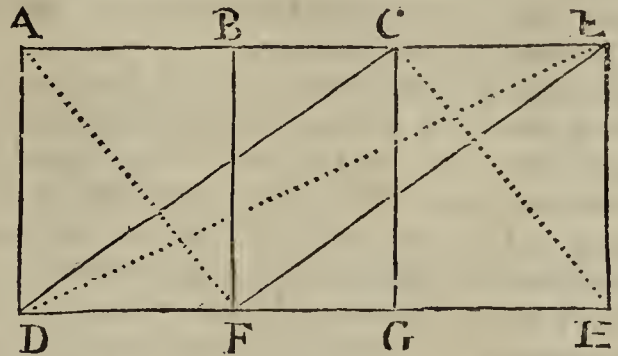
As also, That every *Parallelogram* must be double to a Triangle, having the same or an equal Base and Height 41 *è 1 Eucl.*

For every Triangle that can be drawn on the Base E B, or on a Base equal to it, and having

the same Height, or being between the same Parallel Lines, will be equal to the Triangle A E B, which is half the *Parallelogram* A B, *per Cor. 3.*

### COROLLARY V.

Hence all *Parallelograms* that are between the same Parallel Lines, and on one the same, or equal Bases must be equal.



I say, The *Parallelograms* A F, D E, G E, having the same Base D F, or its equal G H, must be equal to one another.

For the *Parallelograms* A F, and G E, have both the *Describent* and *Dirigent* Lines equal.

And also, A F, and D E, have the same *Describent* Lines D F; and the Line D F, tho' it go not in the same *Dirigent* Line to form the *Parallelogram* D E, yet it goes in the whole but the same Perpendicular Altitude, and only moves slower for going obliquely, but all the *Indivisibles* or *Component* Lines in one, must be equal to those in the other.

### COROLLARY VI.

Hence also follows, that Triangles on the same, or equal Bases must be equal if they are between the same Parallels; because they are the Halves of equal *Parallelograms*.

### COROLLARY VII.

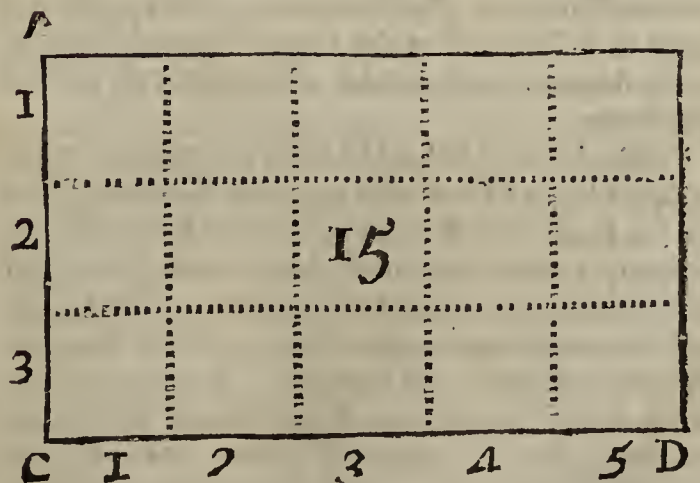
Also from hence is easily proved, That the three Angles *a, b, c*, of any Triangle, are equal to two Right Angles. (See *Fig. 1.*)

For since the Angle  $c + a + b = 2 \angle$ , (because A D is Parallel to E B.)

And that  $b = 0$ , for the same Reason.

Therefore  $b + c + a = 2 \angle$ . *Q. E. D.*

### COROLLARY VIII.





If the Line A C, standing at Right Angles with C D, be divided into three Parts, as C D is into Five; and being made a Describent, be moved along the Dirigent C D, till it come at last to the End of it, and stand in the Position B D; the *Rectangle* A D will by this means be divided into as many little Rectangles as the Unites both in the Describent and Dirigent Line will produce, by being multiplied one by another, that is 15; for 3 times 5 is 15. And this is what is called a *Rectangle* made between any two Lines, or the Product arising from the Parts of the one multiplied by the Parts of the other.

And this is usually in the *Latin* Tongue expressed by the Verb *ducere*, which signifies to *lead* or *guide along*. As, for Instance, if the Line A C were to multiply C D, they would say in that Language, *Duc A C in C D*; that is, set your Line A C perpendicular to C D; and then keeping it always in that Position, lead or guide it along till it comes to the End of C D, and it will by its Motion have formed the Rectangle A D; and by its three Parts, the 15 little ones within it. And therefore in *Latin* Mathematical Books the Product would be thus expressed, A C *Ducta in* C D = 15.

And from hence 'tis plain, that the Product of any two Numbers is equal to a *Rectangular Parallelogram*, made out of the Multiplicand and the Multiplier, or out of the two Factors, as they are called by some Writers; that is, a *Rectangle* whose two Sides are divided into as many Parts as there are Unites in both Factors.

PARALIPSIS, [*παράλειψις* Gr.] (a Figure in *Rhetorick*) is a pretended desire in us of omitting what we say; as if one should say, *I am willing to forget the Wrong that my Enemy has done me; I will not speak of the Injury that I have received from him, &c.*

PARALLELOGRAM, is also an Instrument made of five Rulers of Brass or Wood, with Sockets to slide or set to any Proportion, used to enlarge or diminish any Map or Draught either in Fortification, Building or Surveying, &c.

PARALLELOGRAM *Protractor*, is a Semi-circle of Brass, with four Rulers in Form of a *Parallelogram*, made to move to any Angle: one of which Rulers is an Index, which shews on the Semi-circle the Quantity of any inward or outward Angle.

PARALLELOPIPED, is a solid Figure contained under six *Parallelograms*, the Opposites of which are equal and parallel; or 'tis a Prism, whose Base is a *Parallelogram*. This is always triple to a Pyramid of the same Base and Height, as is demonstrated under *Proportion of Solids*; which see.

PARALLELOPLEURON, [of *παράλληλος* and *πλευρὸν* Gr.] a Word used by some Geometricians for an Imperfect *Parallelogram*, or kind of Trapezium, having unequal Angles and Sides, yet not all so; in regard that at least some of them answer to one another, observing a certain Regularity and Proportion of Parallels; so that they do not extend so largely as Trapeziums, which are any Irregular Four-sided Figures; nevertheless, like them, they are capable of being variously diversified.

PARALOGISM, [*παράλογισμός*] is a pretended Demonstration or Method of arguing, but which is in reality fallacious and false.

PARALYSIS, [*παράλυσις*] the *Palsy*, is an entire Loss of voluntary Motion Sense, or both, either in all the Body, or only in some Part. It comes by either an Obstruction, or Obscission, Contusion or pressing of the Nerves, or by an Indisposition, or ill Conformity of the Muscles. *Blanchard*.

PARALYTICK, [*παρλυτικός* Gr. of *παράλυω* Gr. to *unbind*] a Person affected with a *Paralysis* or *Palsy*.

PARAMESE, (in the *antient Musick*) the ninth Chord or Sound in the Diagramma, or Scale of Musick.

PARAMESUS, is the next Finger to the Middle one, called the Ring-finger.

PARAMETER, by some, as *Mydorgius* and others, called the *Latus Rectum* of a *Parabola*, is a Third Proportional to the *Abscissa* and any *Ordinate*: So that the Square of the *Ordinate* is always equal to the Rectangle under the *Parameter* and *Abscissa*. See the Demonstration under *Parabola*.

This Word *Parameter*, or *Latus Rectum*, is also used as to the *Ellipse* and *Hyperbola*; but in those it hath another Proportion, as you will find under those Words.

PARAMOUNT, in our Law, signifies the Supreme Lord of the Fee: For there may be a Tenant to a Lord, that holdeth himself another Lord; the former of which is called *Lord Mesne*, and the second *Lord Paramount*. And a *Lord Paramount* consisteth only in Comparison, as one Man may be *great*, being compared to a *less*; and *little*, being compared with a *greater*. So that none simply seemeth to be *Lord Paramount* but only the King, who is *Patron Paramount* to all the Benefices in *England*.

PARAPET, in Fortification, is an Elevation of Earth and Stone upon the Rampart, behind which the Soldiers stand secure from the Enemy's great and small Shot, and where the Cannon is planted for the Defence of the Town or Fortrefs. Every *Parapet* having its *Embrasures* and *Merlons*, is about six Foot high on the Side of the Place; and from Four to Five on that towards the Country. So that this Difference of Heights forms a Kind of *Glacis* above, from whence the Musketeers mounting the *Banquet* of the *Parapet*, may easily fire into the Moats, or at least upon the Counterscarp. It ought also to be from 18 to 20 Foot thick, if made of Earth; and from 6 to 8 if of Stone. The Earth is much better than Stone, because Stone will fly to pieces when battered, and do mischief.

This Word *Parapet* is also given to any Line that covers Men from the Enemy's Fire: So there are *Parapets* of Barrels, of Gabions, of Bags filled with Earth, &c.

PARAPHERNALIA, or, according to the Civil Law, *Paraphernalia*, are those Goods which a Wife, besides her *Dower* or *Jointure*, is after her Husband's Death allowed to have; as Furniture for her Chamber, Wearing Apparel, (and Jewels, if she be of Quality) which are not to be put into her Husband's Inventory, especially in the Province of *York*.



**PARAPHIMOSIS**, [*παράριμωσις* Gr.] is a Fault of the Yard, when the *Præputium's* too short; also a Narrowness and Contraction of the Womb.

**PARAPHRENITIS** [of *παρά* and *φρενίτις* Gr.] is madness accompanied with a continual Fever, through the Inflammation of the *Diaphragm*, with Difficulty of Breathing, as the Ancients dream'd. But Doctor *Willis* has confuted this Opinion of it, and says the Matter of it lies in the *Cerebellum*, whereby the Animal Spirits cannot flow, and thence the Midriff and Lungs are troubled. *Blanchard*.

**PARAPHROSYNE**, [*παράφροσύνη*] is a flight fort of Doting in the Imagination and Judgment. *Blanchard*.

**PARAPLEGIA PARAPLEXIA**, [*παραπληξία* of *παρά* and *πλήττειν* Gr. to *strike*] A Species of Paralysis or Palsy, which usually follows an Apoplexy.

**PARASELENE** [*παρασελήνη* Gr.] a *Mock Moon*, is occasioned by the same means as the *Parhelia* are about the *Sun*; tho' not so frequent.

**PARASITICAL Plants**, are those which some call *Epidendra*, because they grow not on the Ground, but on the Arms or Limbs of Trees, as our *Viscum* or *Mistletoe* doth.

**PARASTÆ**, in Architecture, are the same with *Pilasters*, the *Italians* call them *Membretti*.

**PARASTATÆ**. See *Epididymis*.

**PARASYNANCHE**, [*παρασυνάγχη* of *παρά* σύν and *ἄγχειν* Gr. to *suffocate*] is an Inflammation of the Muscles of the upper Part of the *Oesophagus*, with a continued Fever.

**PARATITLA**, [in *Jurisprudence*] short Notes or Summaries of the Titles of the Digest and Code, that have been made by several Lawyers, in order to compare and examine the Connexion of the several Parts one with another.

**PARAVALLE**, in Common Law, signifies the lowest Tenant, or him that is Tenant to one who holdeth his Fee over of another; and is called *Tenant Paravalle*, because it is presumed he hath Profit and *Avayle* by the Land.

**PARBUNCLE**, is the Name of a Rope in a Ship, almost like a pair of Slings: 'tis seized both Ends together, and then put double about any heavy Thing that is to be hoisted in or out of the Ship; having the Hook of the Runner hitched into it to hoist it up by.

**PARCEL-makers**, are two Officers in the Exchequer that make the Parcels of the Escheators Accompts, wherein they charge them with every thing they have levied for the King's Use within the Time of their Office, and deliver the same to one of their Auditors of the Court to make an Account with the Escheator thereof. See the *Practice of the Exchequer*, p. 99.

**PARCELLING** of the Seam of a Ship, is, after it is caulked, to lay over it a narrow piece of Canvas, and then pour on it hot *Pitch* and *Tar*.

**PARCENERS**, is a Word taken either according to the Course of the Common Law, or according to Custom. *Parceners*, according to the Course of the Common Law, are, Where one seized of an Estate of Inheritance, hath Issue only Daughters, and dies, and the Lands descend to the Daughters, then they are called *Parceners*, and are but as one Heir. The same Law is, If he have not any Issue, but that his Sisters be his Heirs.

*Parceners*, according to Custom, are, Where a Man is seized of Lands in *Gavel-kind*, as in *Kent*, and other Places franchised, and hath Issue divers Sons, and dies, then the Sons are *Parceners* by the Custom.

**PARCENARY**, in Law, signifies a holding or occupying of Land *pro indiviso*, by Joint-Tenants, or otherwise, called *Co-parceners*: For if they refuse to divide their common Inheritance, and choose rather to hold it jointly, they are said to hold in *Parcenary*.

**PARCO Fracto**, is a Writ that lies against him that violently breaketh a Pound, and taketh out Beasts thence, which for some Trespas done upon another Man's Ground, are lawfully impounded.

**PARENCEPHALÓS**, the same as the *Cerebellum*.

**PARENCHYMA** [of a *Plant*] the Pith or Pulp; or that inner Part of a Plant, thro' which the Juice is supposed to be distributed.

**PARENCHYMATA**, [of *παρέγχυμα* of *παρ* ἐγχύω to *pour besides*] are the Intrails thro' which the Blood passes for its better Fermentation and Perfection, as the Lungs, Liver, Heart and Spleen, &c.

Sometimes the Word *Parenchyma* is taken in a large Sense for all the Intrails. *Blanchard*.

**PARENCHYMOUS Parts of the Body**, by the Old Anatomists, are reckoned such Fleishy Parts of it as fill up the Interstices between the Vessels, and not consisting of Vessels themselves. But by the Help of the Microscope, and more accurate Observations, it hath been since discovered, that there is no Part of an Animal Body but what is a kind of Net-work of an innumerable Quantity of small Capillary Vessels.

**PARENTHESIS** [*παρένθεσις* of *παρά* between and *ένθεσις* Gr. *Position*] a Number of intricate, intercalary Words inserted in a Discourse, which interrupt the Sense or Thread; but yet seem necessary for the fuller Understanding of the Subject, in Writing inclosed between ( ) to distinguish them from the rest of the Discourse.

**PARERGA**, [in *Architecture*] those Additions or Appendages that are made by Way of Ornament to a principal Work.

**PARERGA**, [in *Painting*] little Pieces or Compartments on the Sides, or in the Corners of the principal Piece.

**PARGETING** or *Parging*, is the Workmens Word for Plaistering of Walls.

**PARHELII**, [*παρήλιοι*] and *Parhelia*, or such *Phænomena* as we call *Mock-Suns*, are the Representations of the Face or Figure of the *True Sun*, by Way of Reflection in the Clouds.

**PARIETAL Bones**, or the Bones of the *Sinciput*, are the thinnest Bones of the *Cranium*, in Form almost square, somewhat long; they are joined to the *Os Frontis* by the *Sutura Coronalis*, to one another in the Crown of the Head by the *Sutura Sagittalis*, to the *Os Occipitis* by the *Lambdoidalis*, and to the *Offa Temporum* by the *Sutura Squamosa*. They are smooth and equal on their Out-side, but on their In-side they have several Furrows made for the Passage of the Veins of the *Dura mater*. They have each a small Hole near the *Sutura Sagittalis*, through which there pass some Veins, which carry the Blood from the Teguments to the *Sinus Longitudinalis*.



**PARIETES**, [in *Anatomy*] *Sides*, the Inclosures or Membranes which stop up, or inclose the hollow Parts of Animal Bodies, especially those of the *Heart*, the *Thorax*, &c.

**PARISTHMIA**, [*παρίσθμια* Gr.] or *Amygdalæ*, are two Glandules of the Mouth tied together by a broad slender Production; they have one common Cavity large and oval, opening into the Mouth. The Use they serve for is, to transmit a certain slimy or pituitous Matter into the Jaws and Mouth. They are called also *Tonsillæ*, which see. *Blanchard*.

**PARK** of the *Artillery*, is a certain Place in a Camp without Cannon-shot of the Place besieged, where the Cannon, Artificial Fires, Powder, and other Warlike Ammunition are kept, and guarded only by Pike-men, to avoid Casualties which may happen by Fire. Every Attack at a Siege hath its *Park of Artillery*.

**PARK** of *Provisions*, is another Place in the Camp on the Rear of every Regiment, which is taken up by the Sutlers, who follow the Army with all Sorts of Provisions, and sell them to the Soldiers.

**PARLIAMENT**, comes from *parler* to speak, and *Ment*, Mind, in *Fr.* And the Writ which summons our *Parliament* runs, *ad consulendum*, &c. *de arduis Regni Negotiis*. And therefore signifies a solemn Conference of all the Estates of the Kingdom, summoned together by the King or Queen's Authority to treat of the weighty Affairs of the Realm. The ancient *Britains* seem to have had no such Assemblies; but that the *Saxons* had something like it, appears from King *Ina's* Laws, who flourished *An. 712. W. the Conqueror* divided the Land among his Followers, in such Manner, that every one should hold of him *in Capite*; and these distributed Part thereof among their Friends and Servants, who for the same owed them *Suit* and *Service* in their Courts. The Chief of these were called *Barons*, who thrice every Year assembled at the King's Court, *viz.* at *Christmas*, *Easter* and *Whitsuntide*: And then the King was wont to come amongst them in his Royal Robes, and with his Crown on his Head, to consult about the publick Affairs of the Kingdom. But some say, this antient Custom was changed by *H. 1.* who in the 16th Year of his Reign, summoned the Commons to the great Council at *Salisbury*. *Cowel's Interpreter*.

**PARODICAL** *Degrees in an Equation in Algebra*, are the several Regular Terms in a Quadratick, Cubick, Biquadratick Equation, &c. the Indexes of whose Powers ascend or descend orderly in an Arithmetical Progression, as  $Z \times 3 Z^2 m + Zr = S$  is a *Cubick Equation* where no Term is wanting; but having all its *Parodick Degrees* the Indexes of the Terms regularly descend thus, 3, 2, 1, 0.

**PARONYCHIA**, [*παρονυχία* Gr.] a *Whitlow*, is a preternatural Swelling in the Fingers, and very troublesome: It arises from a sharp malign Humour, which sometimes gnaws the Tendons, Nerves, the Membrane about the Bone, and the very Bone it self. *Blanchard*.

**PAROTIDES**, [*παρωτίδες* Gr.] are Glandules behind the Ears; also a preternatural Swelling of those Glandules.

**PAROXYSM**, [*παροξυσμός* Gr.] a *Fit*, is Part of the Period of Diseases, whereby they increase

and grow worse. It is either Regular, which returns at certain Times, as in a Tertian or Quartan Ague; or Irregular, that hath no certain Times, but comes sometimes one Day, sometimes another, as the Erratick Ague. *Blanchard*.

**PARRELS**, in a Ship, are Frames made of Trucks, and Ribs, and Ropes, which having both their Ends fastened to the Yards, are so contrived as to go round about the Masts, that the Yards by their Means may go up and down upon the Masts. These also, with the Breast Ropes, do fasten the Yards to the Masts.

**PARRICIDE**, signifies properly him that kills his Father, and may be applied to him that murders his Mother.

**PARSON**, *Persona*, is the Law Term for the Rector of a Church; because for his Time he represents his Church, and sustaineth the Person thereof, as well in suing, as in being sued in any Action touching the same. Formerly he who had a Church by Institution and Induction only for his own Life, was called *Parson Mortal*.

But any Collegiate or Conventual Body, to whom the Church was forever appropriated, was called *Parson Immortal*.

In the new Book of Entries, *Verb. Aid* in Annuity, are these Words: *Et Prædictus A. dicet quod ipse est Persona Prædictæ Ecclesiæ de S. Imperfonata in eadem ad Præsentationem F. Patronissæ*. By which it seems that *Persona* or *Parson* anciently was the Patron, and *Persona Imperfonata* the Rector to whom the Benefice was given by the Patron's Right; which also *Dyer* sheweth, *fol. 221*. So that in Law, the *Parson Imperfonata* is he that hath the Possession of a Benefice or Rectory, be it appropriate or otherwise, by the Act of another.

**PARSONAGE**, or *Rectory*, is a Spiritual Living composed of Glebe-Land, Tythe, and other Oblations of the People, separate or dedicate to God in any Congregation, for the Service of his Church there, and for the Maintenance of the Minister to whose Charge the same is committed.

**PARTES** *Finis nihil habuerunt*, &c. in the Common Law is an Exception taken against a Fine levied.

**Aliquant PART** [in *Arithmetick*] A Quantity which being repeated a certain Number of times becomes always either greater or less than the Whole, as 6 is an aliquant Part of 19 and 7 of 22.

**PARTICLES**, are the very small Parts of which any natural Body is supposed to be compounded; and these are often called the *constituent* or *component Particles* of any natural Body. That these are almost infinitely small, the continual Effluvia which some Bodies do continually emit, and this without any sensible Diminution of their Bulk or Weight, as well as some other Experiments and Observations do plainly shew. But how to make any Conjecture at the several Sizes of these component Particles of Bodies, whether they are all equal in Bulk, or which are greater, and how much they are so, than others, is what *Philosophers* have hardly yet had *Data* or Discoveries enough to determine. But the wonderful Sir *Isaac Newton*, in his excellent Book of *Opticks*, hath open'd a Door into this new World, and hath given some very good Rules whereby to guess at the Bigness of the Component Parts of Natural Bodies. For he having shewn in *Prop. 5. Book 2.*



*Part 3.* That the transparent parts of all Bodies do most probably exhibit the same Colours with thin Plates of Glafs, or thin Bubbles of Water; and on the same Grounds; provided they are of the same Thickness and of the same Density with them. And since their Parts seem for the most part to have the same Density with Water or Glafs, as by many Circumstances 'tis obvious to collect. To determine the Sizes of those Parts, you need only have recourse to the Tables in the aforesaid Book for this purpose, in which the Thickness of Water or Glafs exhibiting any Colour is express'd. Thus if it be desir'd to know the Diameter of a Corpuscle, which being of equal Density with Glafs shall reflect Green of the 3d Order, (as he distinguishes it) by looking into the Table, you will

find that the Number  $16\frac{1}{4}$  shews it to be  $\frac{16}{1000000}$

parts of an Inch. In the general he proves also, *That the Parts of Bodies on which their Colours depend are denser than the Medium, which pervades their Interstices.* Prop. 6. B. 2. part. 3.

He shews also at the End of his *Latin Opticks*, That the Component Particles of all Bodies must be hard or solid, or else *Fluid Bodies* could not congeal; which 'tis certain that *Water, Oyl, Vinegar,* and Spirit or Oyl of *Vitriol* will do by *Cold*; Quicksilver by the Fumes of Lead; Spirit of Nitre and Quicksilver together by dissolving the Mercury, and then evaporating the *Phlegm*: Spirit of Wine, or Urine, by first well dephlegmating them, and then mixing them together, and the Spirit of *Urine* and of *Salt*, by subliming them together to make *Sal Armoniack*. Nay, the very Particles or Rays of Light seem to be *hard Bodies*, otherwise they could not in their different Sides have different Properties, as he hath shewn that they have (see *Light*.) *Hardness* therefore ought to be accounted as the Property of all simple Matter in the Universe; for all Bodies which we know are either hard, or may be made so. And if there are many hard Bodies, as we know is the Case of most, that have Pores interspersed, or *Meatus* placed between their Particles; those Particles themselves that are devoid of any such Vacuities must needs be much harder.

'Tis probable that the most small Particles of Matter do attract one another, and adhere together with the greatest Force; and that these may combine into larger Particles, whose attracting Force is weaker; and many of these latter cohering together may form yet greater Particles of Bodies, whose attracting Force shall be yet weaker. And so on by a continual Series, 'till you come to the greatest of those Particles, on which the *Chymical Operations*, and the Colours of Bodies depend (see *Attraction* and *Colour*) and these cohering into *Masses* may form Bodies of sufficient *Magnitude* to become perceptible by Sense.

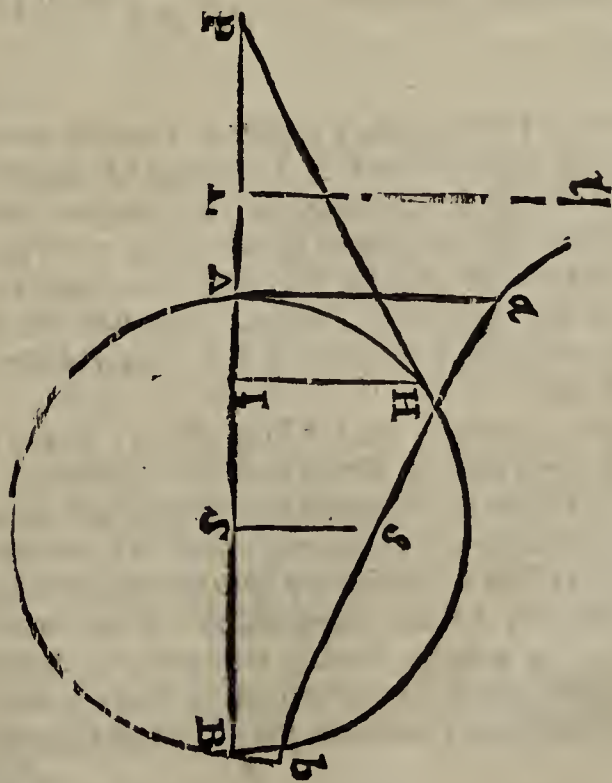
It hath been discovered of late by the wonderful Sir Isaac Newton, Mr. J. Keil of Oxon, and such others as have proceeded on his Principles, *That there is a Power in Nature, by which each Particle of Matter attracts every other Particle with a Force that increaseth in a greater Proportion than that by which the Squares of the Distance decrease; viz. in a Reciprocal Triplicate, or Quadruplicate Ratio of the Distances.* For, were it not so, the Attraction of

these small Particles would not be much greater at the *Point of Contact*, than at some determinate Distance from it; as is evident in the Case of the *Gravity* of greater Bodies, whose Power of Attraction is only reciprocally as the Square of the Distance; for we find that Bodies are of the same Weight, when at the Earth's Surface, or when at 100 Feet Distance. But when a little *Salt* is dissolved in a large Quantity of Water, there is no Attraction of the Particles towards one another, till by evaporating part of the Water, they are brought within a due Distance; and then they presently run towards one another, unite, and form Crystals, whose Parts have a strong Cohesion. (See *Attraction* in this Vol.)

'Tis plain also, that the *attractive Force in these Particles* is (*cæteris paribus*) proportionable to their *Solidity*; for it must be compounded of the *Sums of all the Parts* of each Particle, and those Parts will be most numerous in such Particles as are most solid; *i. e.* in such as have fewest and least Pores or Interstices between their Parts. For Particles or Corpuscles may be so compounded, that the most solid and compact Particles may constitute the lightest Corpuscle: That is, if the interspersed Vacuities between the Particles of *Matter* be large, so that few of them may be diffused thro' a large Space. And such a Corpuscle, tho' consisting of Parts endued with a strong attractive Power, may yet be specifically lighter than another, which may consist of Particles not so solid, but yet much closer put together.

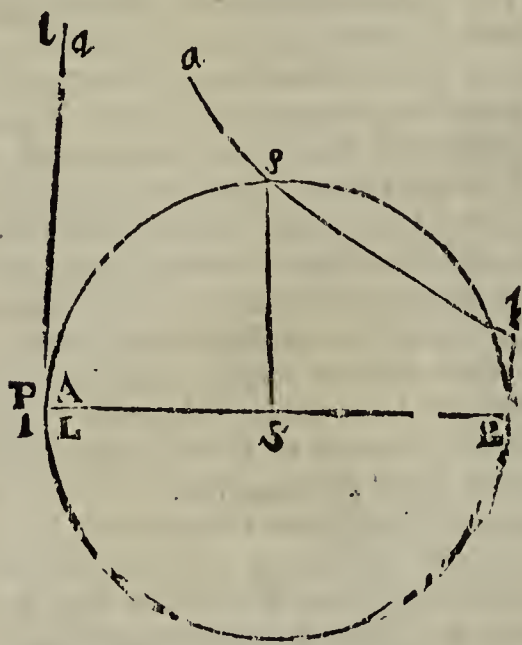
And because this *Natural Philosophy of Particles* is of the greatest Use to be fully understood, I shall here give you (*from Dr. Keil's Book of Animal Secretion, &c.*) some further Propositions about this matter. I say then, *That if any Particles of Matter attract each other with a Force that is in a Triplicate or yet greater Reciprocal Proportion of their Distances: The Force by which a Corpuscle is drawn to a Body, made up of such attractive Particles, is infinitely greater at the Contact, or extremely nearer it, than at any determined Distance from it.*

Suppose the Sphere *AHB* composed of Particles that attract any Particle, as *P*, with a Force reci-





proccally proportionable to the Cubes of their Distances; draw the Tangent  $PH$ , and from  $H$  let fall the Perpendicular  $HI$ : Bisect  $PI$  in  $L$ , and raise the Perpendiculars  $lL$ ,  $Aa$ ,  $Ss$ ,  $Bb$ ; and make  $Ss = SI$ . Then with the Asymptotes  $LB$ ,  $Ll$  thro's describe the Hyperbola  $b s a$ ; and then the Area  $aABb = 2 AS \times SI$ ; will represent the Attraction of the Corpuscle  $P$  by Prop. 81. of Sir Isaac Newton's Princip. But when the Corpuscle  $P$  comes to touch the Sphere in  $A$ , then the Points  $P$ ,  $L$ ,  $A$ ,  $I$  and  $H$  will all coincide; and  $Aa$  becomes the Asymptote of the Hyperbola, and the Area  $aABb$  becomes infinite; and the Rectangle  $2 AS \times SI$  being finite, the Area  $aABb = 2 AS \times SI$ , will be infinite; and consequently the Force by which the Corpuscle  $P$  is attracted by the Sphere, when it touches it in  $A$ , will be likewise infinite.



If the Sphere consists of Particles that attract in a quadruplicate Proportion of their Distances reciprocally, the Force by which a Corpuscle will be drawn to the Sphere will be  $\frac{1}{PS^3 \times PI}$ .

But when the Corpuscle comes to touch the Sphere,  $PI$  becomes  $= O$ , and consequently whatever is divided by it becomes infinite, and therefore the attractive Force at the Point of Contact being proportional to  $\frac{1}{PS^2 \times PI}$ . Will be infinite.

Prop. IV. If a Body consists of Particles attracting with a Force that is in a reciprocal Proportion to the Cubes of the Distances, or in a greater; and if this Force is not infinitely greater than the Force of Gravity at the Point of Contact, or extremly near it, at any determined Distance from the Point of Contact, it must be infinitely less than the Force of Gravity.

This is clear by the last Proposition: For in that Case the Force of Attraction in a Corpuscle removed from the Contact is infinitely less than at the Contact, or extremly near it; but at the Contact it is not infinitely greater than the Force of Gravity by the Supposition: Therefore the Force, by which a Particle removed at a determined Distance from the attracting Body is attracted, is infinitely less than the Force of Gravity.

Prop. V. The Force, by which the Particles of Matter attract each other, when extremly near the

Contact, is not infinitely greater than the Force of Gravity.

This is evident; because in the strongest Cohesion of Particles touching one another, we find that the Weight of some Bodies will pull the Particles asunder, tho' that Body may be prodigiously greater and heavier than the Particles united. Sir Isaac Newton calculates from the Inflection of the Rays of Light, that this Force near the Contact is 10000 0000 0000 0000 greater than the Force of Gravity.

Corol. Particles removed at a determined Distance from the Body attracting, are not acted upon by it; because this Force must then vanish, or which is the same thing, be infinitely less than the Force of Gravity.

Prop. VI. A large Particle attracts not more strongly than a small one of the same Solidity, but a Diversity of Figures causes different Degrees of Attraction in Particles, that are otherwise the same.

This attractive Power acts only on such Particles as are extremly near; and therefore of a large Particle, the remotest Parts conduce Nothing to Attraction: And for the same Reason the attractive Force varies, according as the Particles are Cones, Cylinders, Cubes, or Spheres: And, cæteris paribus, a Spherical Particle has the strongest attractive Power.

Prop. VII. If Particles swimming in a Fluid, attract one another more strongly than they do the Particles of the Fluid, the Force by which they come to each other, will be that by which their attractive Force, exceeds the attracting Force of the Fluid.

For the Particles of the Fluid, that lie directly between the attracting Particles, being more pressed than the other ambient Particles; they will from the Nature of Fluidity, with that Excess of Pressure, drive the other Particles out of their Places, and make way for the attracting Particles to come together.

Prop. VIII. If Particles swimming in a Fluid, are more attracted by the Fluid, than by one another, they will recede from one another, with a Force that will be equal to the Difference of their mutual Attraction, and the Attraction of the Fluid.

For the ambient Particles of the Fluid attracting more strongly, will with their Excess of Force draw the other Particles to themselves and make them to recede from one another.

Prop. IX. The Force, by which Particles attracting one another cohere, is greater, cæteris paribus, where the Contact is greater.

For the Parts that are farther removed from the Contact, conduce Nothing to the Force of the Cohesion; and a greater Power must be requisite to separate two Particles, which cohere only in two Points, than two Particles which cohere in one Point, if the Degree of Cohesion be equal in each Point. Thus two polished Marble-stones (suppose a Foot square) adhere more strongly than any other two Bodies of a Foot square, which are not so solid, but have more Pores and Interstices between their Parts, and which will not receive so good a polish, by which the Parts come to a close Contact with one another.

Prop. X.



Prop. X. *If the attracting Corpuscles are elastick, they must necessarily produce an intestine Motion, greater or lesser according to the Degrees of their Elasticity and attractive Forces.*

For after meeting they will fly from one another with the same Degree of Velocity (abating the Resistance of the Medium) that they met together with; but when they approach other Particles in their Refilition, their Velocity must increase, because they are afresh attracted, and therefore meeting a second time, they will recede with a greater Velocity than they did at their first Concurfion: And so their Velocities will be increas'd by every Concurfion and Refilition, which must necessarily produce a sensible intestine Motion; and the stronger their attractive Force, and the greater their Elasticity, their Concurfions and Refilitions will be the more sensible.

Prop. XI. *Particles attracting one another in a Fluid, moving either with a swift or slow progressive Motion, attract one another just the same, as if the Fluid was at rest, if all the Parts move equally; but an unequal Velocity of the Particles does mightily disturb their Attractions.*

The Particles do all by Hypothesis move equally, and consequently the progressive Motion of the Fluid does not alter their Distances, that is to say, it does not repel them from one another; and consequently they must attract one another with the same Facility as if the Fluid was at rest. But if some Particles move faster than others, some must change their Position in Respect to each other, and those parts, which by the Force of Attraction would have come together, will by this unequal Motion be carried from one another. Thus Salts do not crystallize, nor the terrestrial Particles of Urine attract one another, and unite till the Water, in which they are dissolved, is almost cold; and the intestine Motion of its Particles, caused by Heat, is quieted.

Mr. J. Keil of Oxford in *Phil. Transact.* N. 315. advances these other Theorems about the small Particles of Matter.

1. *That the least Particle of Matter assignable, may so fill any large assigned Space, that the Diameters of the Pores, Interstices, or Meatus between its Parts may be all less than any given Right Line; or, so that all the Parts of such a Particle, shall be nearer to each other than any given Right Line. See his Lecture De Divisibilitate Materiæ, in his Lectiones Physicæ.*

2. *Two Bodies may be assigned or given equal in Bulk, but yet any how unequal in Specifick Gravity, or the Quantity of Matter in each; so that the Sums of the Pores or Meatus in each, shall be nearly equal.*

V. gr. Let there be a Cubick Inch of Gold and another of Air: Tho' the Quantity of Matter in the former may be 20000 Times as great as that in the latter: Yet the Vacuities in the Gold, may be to those in the Air, as 999999 to 1000000; i. e. very nearly equal.

3. *Those Particles, which constitute Water, Air, or any other Fluid, (if they touch one another) are*

V O L. II.

not absolutely solid; but are compounded of other Particles, which do contain within them many Pores or Vacuities.

And he thinks that such Particles of Matter as are the least of all others, and which are perfectly solid and devoid of all interspersed Vacuities may be called *The First or Primary component Particles of Matter, or Particles of the first Composition.*

Such *Moleculæ* as are compounded by the Coalescence of any of these first Particles (only) may be called *Particles of the 2d Composition.* And such *Moles* as are compounded of these second *Moleculæ* by several of them coalescing together may be called *Particles of the third Composition:* And so on till you come to *Particles* out of which the *last Composition of Bodies is made*, and into which they are primarily dissolved.

4. *If a Particle of Matter touch any Body, the Force with which it tends toward the Body, or by which it adheres to it, is proportionable to the Quantity of the Contact, for such Particles as lie remote from the Place of Contact add Nothing to the Cohesion.*

And therefore according to the several Degrees or Quantities of the Contact of Particles, there will arise several Degrees of the Firmness or Cohesion of Bodies. And the greatest Force or Degree of Cohesion, will be when the Surfaces of the cohering Particles are perfectly plane; for there the Force by which any Corpuscle adheres to another, will (*cæteris paribus*) be as the Parts of the Superficies which adhere to, or touch one another.

And from hence, and I believe hence only, can that hitherto difficult Problem, about the Cause of the Cohesion of the Parts of Matter in solid and firm Bodies be solved.

5. *Those Corpuscles or Particles of Matter are most easily separable one from another, whose Contacts with other Particles are fewest and least; as will be the Case of exceeding Particles of a Spherical Figure.*

And from hence, and hence only, can the true and Primary Reason of Fluidity arise.

6. *If the Texture of a Body be such, that its Particles of the last Composition (see Prop. 3.) can be moved a little from their primary State of Cohesion or Contact by some external Force (such as the Weight and Compressure, or the Stroke or Shock of some other Body.) But yet so as that the Particles of the Body don't by this Pressure or Stroke, run into any new Contacts or Cohesions; Then, I say, they will recover again their former Contacts, by the Power of Attraction, or by a Force that will make them tend towards one another: And consequently such a Body, will, after the Pressure or Stroke, recover again its former Figure and Position of its Particles.*

And this is the Reason of the Elasticity of Bodies.

7. *But if the Texture of a Body be such, that when its Particles are by some external Force removed from their former Contacts and Cohesions, they go immediately into others of the same Degree; that Body cannot recover its former Figure and Position of Parts.*

And this is the Texture of such Bodies as are soft, and herein the Reason of their Softness consists.



8. *As Particles which are perfectly solid will attract one another the most strongly; and as in all other Particles the Power of their Attraction is proportionable to their Density or Solidity; so that the attractive Forces of even Particles perfectly Dense or Solid depend much upon their Figures.*

For if a small Particle of Matter be supposed to be formed into an indefinitely small Plate or *Lamina*, of a Figure perfectly circular; and if another Particle of Matter be supposed to be in a Right Line passing thro' the Centre of that Plate, and at Right Angles to its Plane: Then if you suppose that Particle to be distant from the circular Plate a tenth Part of the Radius of that Circle; I say, the Force by which that Corpuscule is attracted by the Plate is 30 times less than if the attracting Matter had coalesced into a spherical Figure: So that the Virtue of the whole Particle had been diffused, as it were, from one Physical Point.

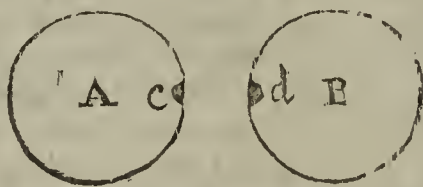
But yet this circular Plate will more strongly attract the Particle than any other Particle of the same Weight with it, that shall be formed into a long and slender Cylinder.

9. *Salts are Bodies, whose Particles of the last Composition are endowed with a very great attractive Force: But yet between those Particles, there are very many Pores or Meatus, which are pervious to the Particles of the last Composition of Water; which aqueous Particles being strongly attracted by the Saline ones, do rush towards them with an Impetuosity, do disjoin their mutual Contact, and dissolve their Cohesion.*

10. *A Body specifically heavier than Water, may have its Magnitude so diminished, that it shall be suspended by or swim in Water, and not descend by its own Weight.*

And this is the Reason that the small Particles of Salts and Metals will swim in such *Menstruums* as will dissolve those Metals, &c.

10. *Greater Bodies attract one another with a less Force than lesser ones do.*



For the Force with which the Bodies *A* and *B* attract one another, exerts it self only in those Particles which are near to one another, the remote ones having no such Force; wherefore there is no greater attractive Force required to move the Bodies *A* and *B* towards one another, than to move *c* and *d*. But the Velocity of Bodies moved by the same Force, are reciprocally proportional to those Bodies: Wherefore the Velocity by which *A* tends towards *B*, will be to the Velocity with which the Particle *c*, apart from the Body tends towards *B*: : as the Particle *c* to the Body *A*; much less therefore is the Velocity of the Body, than that of *c* would be, if it were separated from it.

From hence it comes to pass, that the Motion of the greater Bodies is naturally so slow and gentle,

that 'tis usually impeded by an ambient Fluid or other Bodies round about them. But in lesser Bodies, this attractive Force is very active and vigorous, and is the Cause of a great many noble Effects.

12. *Two Particles of Matter, tho' they do not touch, may yet come so near one another, as that their mutual attractive Force shall much exceed the Force of Gravity.*

13. *If a Particle placed in a Fluid be equally attracted every where by all the ambient Particles of the Fluid, no Motion of the Particle will arise from thence: But if it be attracted by some Particles more, and by others less, it will move that way where the Attraction is greatest, and the Motion produced will be answerable to the Inequality of the Attraction; (i. e.) it will be greater where there is a greater Inequality, and lesser where there is less.*

14. *If a Body be placed in a Fluid, and its Particles do more attract the Particles of the Fluid, than the Particles of the Fluid do one another; and if there be also in that Body any Pores or Meatus, pervious to the Particles of the Fluid; then the Particles of the Fluid will soon diffuse themselves through those Meatus: And if the Cohesion or Connection of the parts of the Body be not so strong but that it may be surmounted by the Impetus of the Particles of the Fluid rushing upon it, and every way into its Pores; there will arise from thence a Dissolution of that Body.*

And from hence you may see the Reason of the Dissolution of Bodies in *Menstruums*: In order to which, Three Things are always necessary.

1. That the Particles of the Body to be dissolved do more strongly attract those of the *Mensstruum*, than those of the *Mensstruum* do one another.

2. That the Bodies have Pores pervious to the Particles of the *Mensstruum*.

3. That the Cohesion of the Constituent Particles of the Body be not so strong, but that it may be broken by the violent Action of the Particles of the *Menstruums* upon it.

15. *If Particles mutually attracting each other do also mutually touch one another, no Motion can arise; for they cannot come nearer to each other: But if they are separated from one another a very small Distance, a Motion must arise from their mutual Attraction. Tho' if they are farther from one another than that they cannot attract one another more than they will the Particles of the Fluid in which they are, and so no Motion also will be produced.*

From these Principles all the *Phænomena* of Fermentation, and of all Effervescences do proceed. And from hence you may see the Reason why Oyl of Vitriol when mingled with a little Water hath so great an Effervescence and Ebullition: For by the Infusion of the Water, the Saline Particles are a little disjoined from their mutual Contact; but since they do much more attract one another than they do the Particles of the Water, and since they are not every way equally attracted, a considerable Motion must from thence arise.

And from hence also you may see the Reason why so great an Ebullition arises from putting Filings of Steel or Iron into the former Mixture of



Oyl of *Vitriol* with a little Water; for the Particles of the Steel have a very great Degree of Elasticity, and from hence a strong Reflection must arise. And from hence also 'tis that some *Menstruums* act with a greater Force, and will sooner dissolve Metals, when mingled with a little Water, than when pure and without such Mixture.

16. If the Particles which do mutually attract each other have no Elasticity, then they are not reflected back from one another, but will form Congeries, Molecula's, Aggregates or Lumps of Particles; from whence what we call a Coagulation arises: And if these Lumps exceed in Specific Gravity that of the Fluid, and are large enough, a Precipitation will succeed. Tho' a Precipitation may also arise from the specific Gravity of the Menstruum in which the Particles swim, its being diminished or increased.

17. If the Figure of Particles mutually attracting each other, when swimming in a Fluid be such, that there is a greater attracting Force in some of their given Parts than in others, as also a greater Contact there; then those Particles will coalesce into Bodies having given Figures; and this Way all Crystallizations arise; and you may by Geometry determine the Figures of the Component Particles from having the Figure of the Crystals given.

18. If between two Particles of a Fluid, another shall interpose, whose two opposite Faces or Sides have very great attractive Forces; this interposing Particle will glew or fasten the other two to it self; and when this is done throughout the whole Fluid, that Fluid will be frozen or turned into Ice.

19. If a Body of some Bulk emit a large Quantity of Effluvia, and the Particles of such Effluvia have a very great attracting Force, then will these Effluvia, when they come near any lesser or lighter Body, by their attracting Force, surmount the Gravity of those Bodies, and lift them up to the Bodies from whence they flow: And since the Effluvia are much more copious and thick at lesser Distances from the emittent Body, than at greater; the light Body will be attracted by still more and more dense Effluvia, and at last be brought to adhere to the emittent Body.

And this Way most of the Phænomena of Electricity may be solved.

PARTIES, in Law, are those which are named in a Deed, or Fine, as Parties to it; as those that levy the Fine, and to whom the Fine is levied: So those that make any Deed, and they to whom it is made, are called *Parties in the Deed*.

PARTING, is one of the Refiners Ways to separate Gold and Silver; 'tis done by *Aqua fortis*, which how to make, and the whole Manner of the Operation, see under *Refining*.

PARTITIONE *Facienda*, is a Writ that lies for those that hold Lands or Tenements *pro indiviso*, and would sever to every one his Part, against him or them that refuse to join in *Partition*, as *Copartners* do.

PARTITION, is a dividing of Land descended by the Common Law, or by Custom, among *Co-heirs* or *Parceners*, where there are two at least;

and this Partition is made Four Ways, whereof Three are by Agreement, the Fourth by Compulsion. The First *Partition* by Agreement is, When they divide the Land equally themselves into so many Parts as there are *Coparceners*, and each to choose one Share or Part, according to Order. The Second is, when they choose some of their Friends to make the Division for them. The Third is by drawing Lots, thus: Having first divided the Land into as many Parts as there are *Parceners*, they write every Part severally in a distinct Scroll, and wrapping it up, throw each of them into a Hat, Bason, or such like thing, out of which each *Parcener* draws one, according to their Superiority; and so the Land is severally allotted. The Fourth *Partition*, which is by Compulsion, is, When one or more of the *Parceners*, by Reason of the Refusal of some other, sues out a Writ of *Partitione facienda*; by Force whereof they shall be obliged to part.

In *Kent*, where Land is of *Gavel-Kind* Nature, they call their Partition *Shifting*.

*Partition* also may be made by Joint-Tenants, or Tenants in Common, by Assent, by Deed, or by Writ.

PARTNERS, in a Ship, are strong Pieces of Timber bolted to the Beams incircling the Masts, to keep them steady in their Steps, and also keep them from rowling (that is falling) over the Ship's Sides. There are also of these *Partners* at the Second-Deck, to the same End; only the Mizen-Mast hath only one Pair of *Partners* in which that Mast is wedged so firm, as that it can by no Means budge. Some Ships sail not well, unless their Masts are loose, and have Leave to play in the *Partners*: But in a Storm this is dangerous, lest the *Partners* should be wronged, (as they say) *i. e.* forced out of their places; for then there is no Help, but to cut the Mast by the Board.

PARTNERSHIP, a Rule in Arithmetick; the same with the *Rule of Fellowship*, which see.

PARTY *Jury*. See *Half Tongue*.

PARTY *per Pale* [in *Heraldry*] is when a Shield has received a Perpendicular cut in the Middle from the Top to the Bottom.

PARTY *per Fesse* [in *Heraldry*] is when the Cut is cross the middle from Side to Side.

PARTY *per Bend dexter* [in *Heraldry*] is when the Cut falls on the upper Corner of the Shield on the Right Hand, and descends athwart to the opposite Corner.

PARTY *per Bend sinister* [in *Heraldry*] is when the Cut falls on the upper Corner and descends across to the undermost lower one.

PAR *Vagum*, a pair of Nerves arising below the *Auditory* ones, from the Sides of the *Medulla Oblongata*, behind the *Processus Annularis*, by several Threads which join together and go out by the same Hole that the *Sinus Laterales* discharge themselves into the *Jugulares*. It is joined by a Branch of the *Nervus Spinalis*, or *Accessorius Willisii*, and by a small Branch of the *Portio Dura*: Immediately after it comes out of the Scull, it gives a small Branch to the *Larynx* as it goes down the Neck, above the *Intercostal Nerve*, by the Side of the *Internal Carotide*. At the *Axillary Artery* it casts back the *Recurrent Nerves*, of which the Right embraces the *Axillary Artery*, and the

Left



Left *Aorta*. These two Branches ascend on each Side of the *Trachea*, or *Aspera Arteria*, to the *Larynx*, where they are spent on the Muscles of the *Larynx* and Membranes of the *Trachea*. This Pair, after it has entered the Cavity of the *Thorax*, sends out several Branches to the *Pericardium*, Heart, Lungs, and Concave Side of the Liver.

This Pair of Nerves was formerly accounted the Sixth, but is now usually reckoned the Eighth.

There is a notable Fibre, or rather Nerve, coming from the Spinal Marrow, about the sixth or seventh *Vertebra* of the Neck, which is so joined to this *Par Vagus*, as if they grew into one Nerve; being covered with it, with the same Coat, from the *Dura Mater*, but appears distinct when that is taken off. This Nerve they call the *Accessory Nerve*, which runs to the Muscles of the Neck and Shoulder-Blade.

Out of the Trunks of the Eighth Pair spring two Nerves that they call the *Recurring Nerves*; the Right of which rises higher, and winds about the *Axillary Artery*; the Left springs lower, and twisting about the Trunk of the descending *Aorta*, recurs or returns back from thence.

Dr. Willis thinks this *Recurrent Nerve* to be really a distinct one from the very Original, to be no Branch of the *Par Vagus*, but only is included in the same Coat or Cover with it, for Safety and Convenience of Passage.

About the first or second Rib this Pair hath a Kind of *Plexus* or Knot, which is called *Plexus Cardiacus*, because it sends out Twigs which go to the Heart and its Appendages.

PARVO *Nocumento*, is a Writ of Nuisance; which see.

PARVUM & *Crassum*, is the Fourth Pair of the Muscles of the Head; so called, because it is but a little one, yet pretty thick. It lieth under the *Complexum Trigemini*, or Third Pair, and rises Nervous from the Transverse Processes of the Six uppermost *Vertebrae* of the Neck, and is inserted into the hinder Root of the Mamillary Process.

PARYLIS, [with Physicians] an Inflammation of the Gums, accompanied with a violent Pain and an Imposthume; which ends sometimes in an Ulcer, and sometimes in a Cancer, *Fistula*, Gangrene, &c.

PASCHA *Clausum*, signifies the Octaves of Easter, or Low Sunday, which closes or concludes that Solemnity. *Die (tali) post pascha clausum*, is a Date in some of our old Deeds. And the first Statute of Westminster, Anno 3 Edw. 1. is said to have been made *lendes mende de la close de Pasche*, that is, the Monday after Easter-Week.

PASCHAL Rents, are Rents or Annual Duties paid by the inferior Clergy to the Bishop, or Archdeacon, at their Easter Visitation. They are also called *Synodals*; which see.

PAS de Sours, a French Term in Fortification, the same with *Berme*; which see.

PASS, a Frame of Boards consisting of 2 or 3 Bottom Boards, and two Side ones, set slope-wise, thro' which the Ore slides down into the Coffer of the Stamping-Mill for the Tin-works, is called by the Workmen the *Pafs*.

PASSAGE, *Passagium*, 'twas a Tribute or Toll paid by Passengers or Travellers for the Repair or Maintenance of some Road or Passage.



PASSANT, [in Heraldry] as a Lion or other Creature passant, signifies walking along leisurely.

PASSAGIO, is a Writ directed to the Keepers of the Ports, to permit a Man to pass over Sea that hath the King's License.

PASSARRADO, is a Rope in a Ship, whereby all the Sheet-Blocks of the Main and Fore sails are haled down after the Clew of the Main sail to the *Cubbridge-Head* of the Main-mast, and the Clew of the Fore-sail to the *Cat-head*. This is to be done when the Ship goes large; and they are also kept firm down, and hindered from flying up, by this *Passarado Rope*.



PASSION-CROSS, [in Heraldry] is so called, because it is supposed to resemble the Cross, on which our Saviour suffered, not crossed in the middle, but somewhat below the Top, as in the Figure.

PASSPORT, signifies a Licence made by any one that hath Authority, for the safe Passage of any Man from one Place to another.

PASSIVE Principles. So the Chymists call *Water* and *Earth*, because either their Parts are at rest, or else at least not so rapidly moved as those of Spirit, Oil, and Salt, and so do serve to stop and hinder the quick Motion of the *Active Principles*. Besides if these Principles could be drawn pure, they would have nothing in them but bare Bulk, Figure, Colour and Weight; the one in a Fluid, the other in a Solid Form; and would be without either Smell, Taste, &c. or any Active Operations.

PASTILIS, are Odoriferous *Tables*, or *Trochisks* made up of Perfumes or Odorous Bodies, with Mucilage or Gum *Tragacanth*.

PATE, in Fortification, is a kind of Platform like what they call an Horseshoe, not always regular, but generally oval, encompassed only with a Parapet, and having nothing to flank it. It is usually erected in Marshy Grounds to cover a Gate of a Town.



PATEE, a Term in Heraldry for a Cross of this Figure. The Field is Sable a Cross Patee Argent, by the Name of Cross. This Form of a Cross is called also *Formee*.

PATELLA. See *Mola genu*, the Knee Pan.

PATENTS. See *Letters Patent*.

Note, That *Patents* differ from Writs, and that a Coroner is made by Writ and not by Patent.

PATENTEE, is he to whom the King grants his Letters Patents.

PATER NOSTERS [in Architecture] are certain Ornaments placed underneath the Ovolo, cut in Form of Beads, either round or oval.





PATER NOSTER [in Heraldry.]

**PATHETICK** [*Patheticus* παθητικός of πάθος Gr. *Passion or Affection*] relating to the Passions, or that is proper to excite or awake them.

**PATHETICK Nerves**, are the Fourth pair arising from the Top of the *Medulla Oblongata*, (and so is different from all others, which arise either from its Base or Sides) behind the round Protuberances, called by Anatomists the *Nates* and *Testes* of the Brain; whence bending forwards by the *Sides* of the *Medulla Oblongata*, they presently hide themselves under the *Dura Mater*; under which proceeding a while, they pass out of the Skull, each in a single Trunk, at the same Hole with the Optick Nerves, (and they communicate with no other in their whole Passage) and are bestowed intirely, as *Willis* saith, on that Muscle of the Eye which they call *Trochlearis*, because it serves to rowl the Eye round about; which being a Motion that is usually consequential upon some Passion of the Mind, such as Love, &c. these Nerves are therefore very properly called *Oculorum motores pathetici*.

**PATH of the Vertex**, a Term frequently used by Mr. *Flamsteed* in his *Doctrine of the Sphere*, and signifies a Circle described by any Point of the Earth's Surface, as the Earth turns round its Axis. This Point is considered as Vertical to the Earth's Centre, and is the same with what is called the *Vertex* or the *Zenith* in the *Ptolemaick* Projection.

The Semi-diameter of this *Path of the Vertex* is always equal to the Complement of the Latitude of the Point or Place that describes it; that is, to that Place's Distance from the Pole of the World.

**PATHOGNOMONICK**, [of πάθος *passion* and γνωμονική of γνώσκεν, Gr. *to know*] a Term in the Art of Medicine, is a proper inseparable Sign which agrees only to such a thing, and to all of that kind, and tells the Essence of its Subject, and also lasts from the Beginning to the End; as in a true Pleurisie there's always a continual Fever, hard Breathing, and Stitches with a Cough. *Blanchard*.

**PATHOLOGY**, [παθολογία of πάθος and λόγος, Gr. *a Discourse*,] is a Part of Physick that teacheth us the preternatural Constitution of a Man's Body, so as thereby to discover the Nature and Causes of Diseases.



PATONCE. The Herald's Term for one of their Crosses of this Figure.

*Gules, a Cross Patonce, Argent,* by the Name of *Latimer*.



PATRIARCHAL Cross [in Heraldry] is so called because the Shaft is twice cross'd, the lower Arms being longer, and the upper shorter, as in the *Escutcheon*.

**PATRIMONY**, is an Hereditary Estate, or Right, descended from Ancestor. The Legal Endowment of a Church, or Religious House, was called *Ecclesiastical Patrimony*.

**PATRON**, is used in the Civil Law for him that hath manumitted a Servant, and thereby is both justly accounted his great Benefactor, and challengeth certain Reverence and Duty of him during his Life.

In the Canon and Civil Law it signifies him that hath the Gift of a Benefice; and the Reason is, Because the Gift of Churches and Benefices was belonging unto such good Men as either built or else endowed them with some great part of their Revenue.

**PATRONAGE** the Right which belongs to the Founder of a Church or Benefice. These Rights consist in having the Nomination or Presentation to the Benefice that he has Founded or Endow'd; in having the honourable Rights of the Church it being entered in the Chancel.

*Lay* PATRONAGE is such as is attach'd to the Person either as Founder, or Heir to the Founder; or as the Possessor of a See, to which the Patronage is annexed.

*Personal Lay* PATRONAGE is that which belongs immediately to the Founder of a Church, and is transmittable to his Children and Family; without being annexed to any Fee, and cannot be alienated or sold.

*Real Lay* PATRONAGE, is that which is attach'd to the Glebe, or to a certain Inheritance, which may be sold together with the Glebe to which it is annexed.

*Arms of* PATRONAGE [in Heraldry] are those on the Top, some of which are Marks of Subjection and Dependence.

**PATRONYMICK** [πατρωνυμικός of πατήρ *a Father*, and ὄνομα, Gr. *a Name*] a Term apply'd by Grammarians to such Names as have been given to the Race or Lineage of any Person, and which were formed from him, who was the Chief or Founder of it, as *Heraclides* from *Hercules*, *Aeneades* from *Aeneas*.

**PATROUILLE**, or *Patroul*, as we generally pronounce it, is a Round of Soldiers, to the Number of Five or Six, with a Serjeant to command them: These set out from the *Corps de Gards*, and walk round the Streets of a Garrison, to prevent Quarrels, Mischiefs, &c. and to keep all in Order, Peace and Quietness.

**PATTES**, [in Heraldry,] the Paws of a Beast.

**PAVILLON** [in Architecture] a Turret or Building that for the most Part is insulated and under a single Roof; which is sometimes Square, and sometimes in the Form of a Dome; also a projecting Piece in the Facade of a Building, marking the middle of it, and sometimes it flanks a Corner.

**PAVILLON** [in Heraldry] a Covering in the Form of a Tent, which invests or wraps up the



Armories of divers Kings and Sovereigns, depending only on God and their Sword.

**Prompt PAYMENT**, is the discharging a Debt before the Expiration of the Term granted by the Creditor.

**PAVIMENTA** *Teffellata*. See *Teffellata*.

**PAUPER**. See *Forma Pauperis*.

**PAUSE** or *Rest*, in Musick, is a Silence or Artificial Intermision of the Voice or Sound, proportioned to a certain Measure of Time, by the Motion of the Hand or Foot.

These *Pauses* or *Rests* are always equal to the Length or Quantity of the Notes whereto they are annex'd, and are therefore called by the same Names, as a *Long-rest*, *Breve-rest*, *Semi-breve-rest*, &c.

*Odd Rests* are those which take up only some part of a *Semi-breve's* Time or Measure, and have always reference to some *Odd Note*: for by those two *Odds* the Measure is made even.

**PAUNCH**, or *Panch*, is those Matts made of Sinnet, which in a Ship are made fast to the Main and Fore-yards, to keep them from galling against the Masts.

**PAWLE**, in a Ship is a small Piece of Iron bolted to one End of the Beams of the Deck, close to the Capstan, but yet so easily as that it can turn about. Its use is to stop the Capstan from turning back, by being made to catch hold of the Whelps: Therefore they say, *Heave a Pawle!* That is, Heave a little more for the *Pawle* to get hold of the Whelps: And this they call *Pawling the Capstan*.

**PAY**, the Seamen say, *Pay more Cable*, that is, let out more Cable; and *pay cheap*, that is, at the turning the Anchor out of the Boat, to turn it over-board faster.

**PAYING**. The Seamen call laying over the Seams of a Ship a Coat of hot Pitch, *paying her*; which when 'tis done with Canvass, is called *Parcelling*. Also, when after she is *Graved*, and her *Soil* burned off, a new Coat of Tallow and Soap, or one of Train-Oil, Rosin and Brimstone, boiled together, is put on upon her, that is called *Paying of a Ship*. They say also sometimes, when in tacking about, a Ship's Sails, being backstay'd, fall all flat against the Masts and Shrouds, *she is payed*.

**PEAN**, in Heraldry, is when the *Field* of a Coat of Arms is *Sable*, and the Powderings are *Or*.

**PEARL**, [in *Heraldry*] is used by such as Blazon by precious Stones, instead of Colour and Metals for *Argent* and *White*.

**PECTEN** *Arboris*, is the Grain of the Wood of any Tree.

**PECTEN**, in Anatomy, is the same with the *Regio Pubis*, or lower Part of the *Hypogastrium*.

**PECTINEUS**, is a Muscle of the Thigh; so called from its Beginning at the *Os Pubis* or *Pectinis*. It has a thick, broad, and fleshy Origination from the External part of the said Bone, between the *Psoas Magnus* and the *Iliacus Internus*, and second Head of the *Triceps*; and descending obliquely backwards, it becomes a flat strong Tendon near its Implantation to the Asperity on the Posterior part of the *Os Femoris*, immediately

below the lesser *Trochanter*, at the Insertion of the *Psoas Magnus* and *Iliacus Internus*.

This acting together with the *Psoas Magnus* and *Iliacus Internus*, doth not only draw the *Os Femoris* upwards, but direct it outwards, by its Curve Descent from its Origination to its Insertion at the Posterior part of the *Os Femoris*; which is a Provident Contrivance of Nature in walking, since the Thigh-Bones by their Oblique Position do thereby render the Toes liable to turn inwards.

**PECTINIS**, or *Pubis Os*, the Share-Bone, is the lower and inner, or fore-part of the *Os Innominum*; and even before, is joined to its Fellow by a Cartilage, called *Synchondrosis*, which is much thicker, but looser and softer in Women than in Men; for in Women, one Bone can a little recede from the other in Travail, to make way for the *Fœtus*. It has a very large *Foramen* between the *Sinus* of the *Coxendix*, and that part whereby it is joined to its Fellow, making room for two Muscles of the Thigh; and above this *Foramen* is a *Sinus*, by which the Crural Veins and Arteries pass to the Thighs. The Upper part of this Bone is called its *Spine*, into which the Muscles of the *Abdomen* are inserted.

**PECTORALS**, or *Pectoral Medicines*, are such as are used in Diseases of the Breast, which by attenuating, or thickning, or allaying the Heat thereof, render the Matter which causes Coughing, fit to be expectorated or spit out. *Blanchard*.

**PECTORALIS**, a Muscle of the Arm, so called from its Situation. This hath a broad semicircular fleshy beginning above, from near half the Inferior part of the *Clavicula*: Below, from the *Os Pectorale*, and all the Cartilaginous Endings of the Six superior Ribs, and from the Bony part of the Seventh, it hath a distinct *Fasciculus* of fleshy Fibres, (which sometimes is confounded with the *Obliquus Descendens Abdominis*.) From this large Origin it marcheth transversely, and becometh narrower but thicker, and lessens it self as it passeth over the upper part of the *Biceps Cubiti*, and is inserted by a short, but broad, strong Tendon, to the Superior part of the *Os Humeri*, above the Termination of the *Deltoides*. The Fibres of this Muscle decussate each other, near their Implantation to the *Os Humeri*; those of the Superior part running downwards, and those of the Inferior marching up, intersect the former in Acute Angles. When it acts it moves the Arm either obliquely upwards, or directly forwards, or obliquely downwards, according to the various Direction of its *Series* or *Fibres*.

**PECULIAR**, signifies a particular Parish or Church that hath Jurisdiction within its self, for *Probat* of Wills, &c. exempt from the Ordinary, and the Bishops Courts.

The King's Chapel is a Royal *Peculiar*, exempt from all Spiritual Jurisdiction, and referred to the Visitation and immediate Government of the King himself, who is Supreme Ordinary.

It is an Ancient Privilege of the See of *Canterbury*, That wheresoever any Mannors or Advowsons do belong to it, they forthwith become exempt from the Ordinary, and are reputed *Peculiars*.

**PEDESTAL**,



**PEDESTAL**, in Architecture, is that part which supports a Pillar or Column, having its proper Base and Cornice different, according to the several Orders of Architecture.

The *Tuscan Pedestal*, being the most simple of all, hath only a *Plinth* for its Base, and an *Astragal* crown'd for its *Cornice*.

The *Dorick Pedestal*, (according to *Palladio*) borrowing the *Attick* Base, ought to have for its Height  $2 \frac{1}{2}$  Diameters of the Column taken below. But no *Pedestals* to this *Order* are seen among the Ancient Buildings.

The *Ionick Pedestal* is Two Diameters and about Two thirds high.

The *Corinthian Pedestal* hath the Fourth part of the Column for its Height, being divided into Eight parts; whereof one must be allowed for the *Cymatium*, two others for the Base, and the rest for the Dye or Square.

The *Composit Pedestal* ought to have the Third part of the Pillar for its Height.

**PEDICLE** [in *Botany*] is that little Stalk or Tail, by which the Leaf, Fruit, or Flower, is joined to the Branch or Stem.

**PEDICULARIS Morbus.** See *Phthiriasis*.

**PEDICULUS**, in [Botany,] is the Foot-stalk of any Leaf, Flower, or Fruit.

**PEDIAEUS** [in *Anatomy*] is the second of the Extensor Muscles of the Foot; which takes the Origin in the lower Part of the *Perinæum* and annular Ligament, and is divided into four Tendons, which are inserted into the External Part of the first Articulation of the four Toes.

**PEDIMENT**, in *Architecture*, is a Triangular Frame with Cornish raised over the Front of a House, and sometimes over Doors, &c. the same as *Fronton*.

**PEDIUM.** See *Tarsus*.

**PEDOMETER** or *Podometer*, [*πεδόμετρον* of *πῆξ* a Foot, and *μέτρον*, Gr. *Measure*] a mechanical Instrument in form of a Watch, composed of various Wheels with Teeth, which catch into one another, all disposed in the same Plane, which by means of a Chain or String fastened to the Foot of a Man, or the Wheel of a Chariot, advances a Notch each Step or Revolution of the Wheel, so that if the Number be mark'd on the Edge of the Wheel, the Number of Paces may be known, or the Distance from one Place to another exactly measured.

**PEDRERO**, or, as it is usually called by the Seamen, *Petterero*, is a small Piece of Ordnance, most used on board of Ships to fire Stones, Nails, broken Iron, or Partridge-shot, on the Enemy, when he attempts to board you. Most of these are open at the Breech, and have the Chamber to take out, and to be loaded that way, and not at the Muzzle.

**PEDUNCULI**, [in *Anatomy*] are two medullary Processes of the *Cerebellum* by which that Part is joined to the *Medulla Oblongata*.

**PEEK**, a Sea-word, used in these Senses: An

Anchor is said to be *a-peek*, when a Ship being about to weigh, comes so over her Anchor, that the Cable is perpendicular between the Hawse and the Anchor; and to bring the Ship thus, is called *Heaving a-peek*.

They say also, *Peek the Miffen*; that is, Put the Miffen-yard right up and down by the Mast.

A Ship is said to *Ride a-peek*, where she lies with her Main and Fore-yards hoisted up; and then having one end of the Yards brought down to the Shrouds, the other is raised up an end: And this is done to contrary Sides; (*i. e.*) the Star-board Yard-arm of the Main-yard comes down to the Star-board side, and so doth the Larboard end of the Fore-yard; so that the Yards appear a-crofs each other like St. *Andrew's* Crofs. The Way to do this, is, To let go the Starboard Top-sail-sheets from the Main-yard, and then topping up the Larboard-lifts: And so quite contrary for the Fore-yard.

To *Ride a-broad peek* is much after the same manner, only the Yards are raised up but half so high.

The Reason why they thus *peek* up their Yards is, lest lying in a River (and they hardly ever use it but then) with their Yards a-crofs, another Ship should be foul upon them, and break their Yards.

There is also a Room in the Hold of a Ship, that is called the *Peek*: 'Tis from the Bitts forwards to the Stern. Here Men of War keep their Powder; and Merchant-men, Outward-bound, place their Victuals here.

**PEER**, a Mass of Stone, &c. opposed to the Sea; or a great River, to defend against its Force and for the Security of Ships that lie in Harbour there.

**PEERS**, in Architecture, are a kind of Pilasters or Buttresses, for Support, Strength, and sometimes Ornament.

**PEERS**, *Pares*, in our common Law, are those that are empannelled on an Inquest upon any Man for the convicting or clearing him of any Offence for which he is call'd in question; and the Reason thereof is, because 'tis the Course and Custom of our Nation, that every one shall be tried by his *Peers* or Equals. The Word is used also for the Nobility of this Realm, and Lords of the Parliament, who tho' distinguished as to degrees of Nobility, yet are *equal* in all publick Actions, as in Votes of Parliament, in passing Tryals on Noblemen.

**PEGASUS**, a Constellation in the Northern Hemisphere, containing 23 Stars.

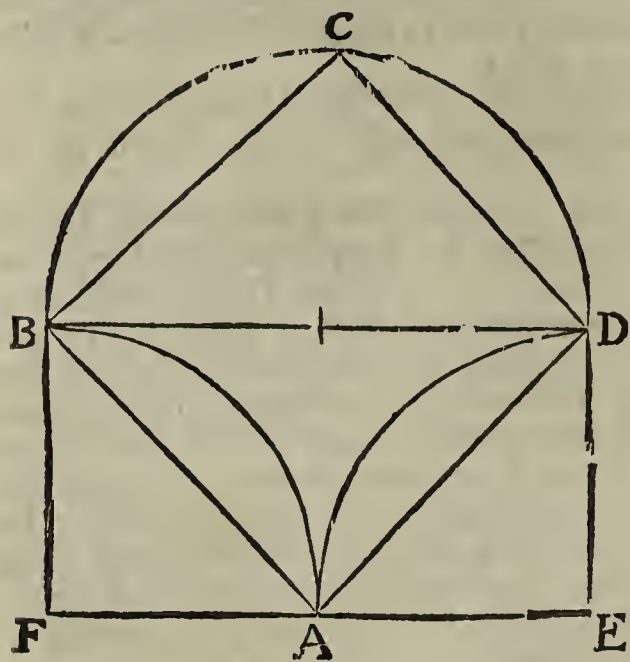
**PEIRCED**. When any *Ordinary* or *Charge*, in Heraldry, hath an Hole in it, so that the *Field* appears through, they say that *Ordinary* or *Charge* is *pierced*.

**PELAGIÆ**, is a Term used by the Writers of Natural History, to express such Sea Shell-fishes, as never or very rarely are found near the Shores, but always reside in the Deep, in those parts of the Bottom of the Sea which are most remote from Land.

**PELECOIDES**, [*πελεκοειδής* of *πέλεκυς*, Gr. *a hatchet* and *εἶδος*, Gr. *shape*,] is the Name given by some to the Figure B C D A, contained under the



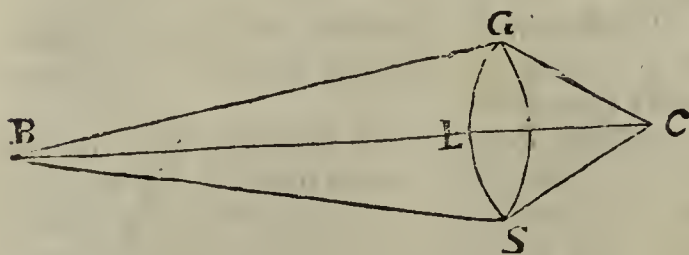
the two inverted Quadrantal Arks A B and



A D, and the Semi-circle B C D, whose Area is = to the Square A C, and that to the Rectangle E B.

'Tis equal to the Square A C, because it wants of the Square on the Left Hand the two Segments A B and A D, which are equal to the two Segments B C and C D, by which it exceeds it on the right Hand.

PENCIL of Rays in *Opticks*, is a double Cone of Rays joined together at the Base; one of which hath its Vertex in some one Point of the Object, and the Glas G L S for its Base; and the other hath its Base on the same Glas, but its Vertex in the Point of Convergence, as at C.



Thus : B G S C is a Pencil of Rays, and the Line B L C, is called the Axis of that Pencil.

PENUMBRA, in Astronomy, is a faint kind of Shadow, or the utmost edge of the perfect Shadow, which happens at the Eclipse of the Moon; so that it is very difficult to determine where the Shadow begins, and where the Light ends.

PELIDNUS, [*πελιδνός* of *πελιδνώω*, Gr. to render livid,] is a Black-and-blue Colour in the Face, frequent in Melancholick Men.

PENDANT, [in *Heraldry*] a Term apply'd to the Parts hanging down from the Label, to the Number of 3, 4, 5, or 6 at most, which when they are more than 3, must be specified in Blazoning.

PENDANTS of a Ship are of two kinds.

1. Those long Colours or *Streamers*, cut pointing out towards the end, and there divided into two Parts, and which are hung out at the Heads of the Masts, or at the Yard-Arm ends, are called Pendants; and are used for shew, and sometimes for Distinction of Squadrons.

2. That short Rope is called a *Pendant*, which at one end is fastened to the Head of the Mast, or to the Yard or to the Clew of the Sail, and at the other end hath a Block and Shiver, to reeve some running Rope into. Thus the Pendant of the *Tackle* is made fast to the Head of the Mast; and the Pendants to the *Back Stays* are fastened to, and hang down on the Inside of the *Shrouds*. Also all the Yard-Arms, except the *Miffen*, have of these Pendants, into which the Braces are reeved.

PELLETS, a Bearing in Heraldry. See *Balls*.

PENDULOUS Flowers, [in *Botany*] hanging down, or such as hang their Heads downwards, the Stalk not being able to support them upright.

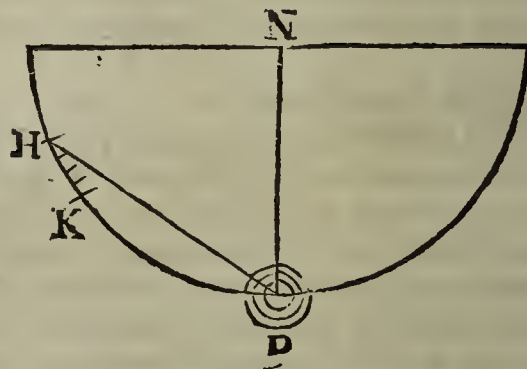
PENDULUM, is a Weight hanging at the end of a String, Chain, or Wire, by whose *Vibrations* or *Swings* to and fro, the Parts or Differences of Time are measured.

The Velocities of *Pendulums* in their lowest Points are as the Chords of the Arks they fall from or describe.

Thus if the *Pendulum* N P be let fall from the Height H, its Velocity at P will be expounded by the Chord H P. (*In the Figure following.*)

'Tis said that *Ricciolus* was the first that attempted to measure Time by the *Pendulum*, and therein he was followed, thro' near about the same Time, by *Langrenus Vendelinus*, *Mersennus*, *Kircherus*, &c. some of which declare they knew nothing of *Ricciolus's* Attempt: But the first that applied it to a Movement, Clock, or Watch, was Mr. *Christopher Hugen*, who brought it also to a good Degree of Perfection.

The Learned Sir *Isaac Newton*, in his Accurate Experiments on *Pendulums*, from that the Matter of all Bodies is exactly proportionable to their Weight.



If the *Pendulum* P, be let fall from the Height H, and then at its return that way come up again as far as K, the Ark H K represents the Retardation arising from the Resistance of the Air.

The shorter Arks any *Pendulum* describes, the equaller will the Vibrations be to one another; and when the Arks are exceeding small, the Vibrations will be nearly equal as if the *Pendulum* did swing in a *Vacuum*. Wherefore it seems to be a Mistake in those who admire a Clock or Watch for its *Pendulums* swinging far, or taking a great Compass as they call it.

PENDULUMS, *Mersennus* found the length of a *Pendulum* that wou'd swing Seconds to be 3



Feet 6 Inches, and since 'tis agreed that in our Latitude, it is just 39 Inches, 2 Tenths.

A *Pendulum* of 10 Inches, wanting about one Tenth of an Inch, will very near swing half Seconds, or the 120th part of a Minute of Time; which is the 7200th part of an Hour.

The Lengths of *Pendulums* (which are always accounted from the Centre of Oscillation, to the Centre of the Ball or Bob) are to each other in a Duplicate Proportion of the Times in which their Vibrations are respectively performed; or are as the Squares of the Vibrations performed in one and the same time. Wherefore the Times must be in Subduplicate Proportion to the Lengths. Sir *Isaac Newton* demonstrates, *Cor. 2. Prop. 54. Princip.* That if the Force of the Movement of a Clock required to keep a *Pendulum* in Motion, could be so compounded with the gravitating Force of the *Pendulum*, that the whole Force or Tendency downwards, shall be as the Line which arises by dividing the Rectangle under the Semi-ark of the Vibration and the Radius, is to the Sine of that Semi-ark, then all the Oscillations shall still be made in the same space of Time.

### P R O B L E M S.

I. *To find the Length of a Pendulum which shall make any Assigned Number of Vibrations in a Minute.*

Let the Number of *Vibrations* be 50, the Length of a String counted from the *Point of Suspension*, to the Centre of *Oscillation*, or of the Bullet or Round Ball at the end of it, is required.

Since the Lengths of *Pendule's* are to each other as the Squares of their *Vibrations*. And that a *Pendule* Vibrating Seconds (or 60 times in a Minute) is by Experience found to be of the length of 39 Inches and  $\frac{2}{5}$  of an Inch.

I here use Sir *Jonas Moor's* Computation.

Say, as the Square of 50, (which is 2500): to the Square of 60 (which is 3600) :: So is 39, 2 : to the Length of the *Pendulum* required: which will be found to be 56,4 Inches. See the Work.

As 2500 to 3600 :: so 39, to 2

39,2  


---

7200  
32400  
10800

25 | 00) 14112 | 00 (56,4

...

125

161

150

112

100

12

But for ready Practice; since in these Questions

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ons the Product of the mean Terms will always be 1411200 (that is, the Product of the Square of 60 Multiplied by 39,2.) i. e.  $3600 \times 39,2$ . You need only divide that Number by the Square of the Number of Vibrations assign'd, and the Quotient will give the Length of a *Pendulum*, that shall vibrate just so many times in a Minute.

### P R O B L E M II.

*The Length of a String and Plummet being known (reckoned as before from the Point of Suspension to the Centre of the Weight;) To find the Number of Vibrations such a Pendulum shall make in a Minute.*

This is the Reverse of the former Problem; therefore say, As the Length given suppose, 56,4, to the Length of the Standard *Pendulum* swinging Seconds, viz. 39,2. So is the Square of the Vibrations of the *Standard Pendulum* to the Squares of the Vibrations sought. See the Work.

As 56,4 : 39,2 :: 3600 : 2500, as will be found by working the *Golden Rule* as before. And the Square Root of 2500, will be 50, the Number of Vibrations sought.

But for use (here as in the former Problem) you need only to divide 1411200 by the Length, and it gives the Squares of the Vibrations, as there you divided by the Square of the Vibrations to find the Length.

### U S E.

And these two Problems may be of excellent use, both to regulate the Motion of a Clock or Watch, and exactly to measure Time without either; which may gratifie and assist the Curious in observing *Eclipses*, especially those of the *Satellites* of *Jupiter*, and in the Transits of the Moon under the fix'd Stars, and her Occultations of them: Whose Duration may be thus easily measured, without Clock, Watch, or any such way of distinguishing Time.

As for Instance, Suppose you were on a Journey or Voyage, or some place where you cannot have the conveniency of a good Clock or Watch, &c. and yet you would willingly observe the Duration of an Eclipse; which by your Table you know will happen such a Night, and near such a time of it.

Hanging up a String and Weight on a fine Pin, and letting it swing just at the Entrance of the Shadow on the Moon's Orb; let a Correspondent or Servant carefully count the Vibrations, and marking them down with a Pencil, or some such way; (moving the *Pendulum* dexterously also that way that 'tis going, when 'tis almost at rest, by a gentle push of his Hand, and by that means keeping it in constant Motion;) the Number of the Vibrations will be known, during the whole Eclipse; which note down on a Piece of Paper, and measuring exactly the Length of your String in Inches, and Decimal parts of an Inch: Divide (by this Problem) 1411200 by the Length of your *Pendulum*, and the Quotient will afford you a Number, whose Square Root is the Number of Vibrations the *Pendulum* you employ'd made in one Minute. Divide therefore the Number of all the Vibrations, during the whole time of Observation,



vation, by 60, and the Quotient will be the Number of Minutes the Eclipse lasted.

N. B. 'Twill be best to use a pretty long String, because the Vibrations being by that means slower, they may be the more distinctly counted. If at such a time you are furnished with a good Foot Rule, you may let your *Pendulum* be just 39,2, and then each Vibration will be a Second: But if you are destitute of such an Advantage, you may, as before, hang up a *Pendulum* at a venture, and by another String, or some such way, taking its exact Length, you may keep it by you with the Number of all the Vibrations, and compute the Time afterwards at your Leisure.

### P R O B L E M III.

*To find the Length of any String which hath a Weight hanging at it, without coming to measure it; or without making use of any Quadrant, or such like Instruments, to take Heights.*

Let the String and Weight annex'd be made to swing; and at the same time hang up a *Pendulum* of any known Length, (as suppose a Yard) and set it a vibrating likewise, so that both the *Pendulums* may swing together; to effect which, you must let the *Pendulum* you hang up go away just when the other you would measure is beginning to make any Vibration: This done, stay till the *Pendulum* you hung up hath made a Competent Number of Vibrations (as suppose about 50 or 60;) and let a Correspondent count how many Vibrations the *Pendulum*, whose length is sought, made in the same time: And let us suppose, that *That* made 10 Vibrations while your String and Plummet made 60; since, as was said before, *The Lengths of Pendulums are to each others as the Squares of their Vibrations*: If you divide 3600 (the Square of 60) by 100, (the Square of 10) the Quotient will be 36, which will shew you that the String sought was 36 times as long as that which you hung up; *i. e.* was in length 36 Yards, or 108 Foot.

And thus you may easily find the height of any Church or Theatre, by means of a Branch Candlestick which hangs from the Roof: For if you hang up a String and Plummet of a Yard long, suppose, (or of any known length) and make this Candlestick and your *Pendulum* begin to swing both together (which is easily done by the help of a Correspondent:) The Vibrations that the Candlestick makes, while your *Pendulum* makes any Competent Number, will easily help you to the Length of the String or Wire, that holds the Candlestick, and consequently the height of the Church will be known likewise.

As in the former Example, Suppose the Candlestick made 10 Vibrations, while your *Pendulum* of a Yard made 60, then it is 36 Yards, or 108 Feet from the Centre of the Candlestick, to the end of the Rope or Wire that holds it to the Roof; to which, adding the height of the Centre of the Candlestick above the Ground, you have the whole height of the Church.

### P R O B L E M IV.

*According to these Principles and Experiments on*

*Pendulums, it will not be difficult to estimate nearly the Depth of a deep Well, by the fall of a Stone into the Water from the Mouth: Or the Distance that any Ship at Sea, or that any Fort is off, by the Time between seeing the Flash of the Powder, and hearing the Report of the Gun: Or the Distance that any Thunder-Cloud is off, &c.*

For Sir *Isaac Newton* hath found that a Sound moves 968 Feet in a Second of Time.

'Tis asserted also by Mr. *Hugens*, and now generally agreed to, That a heavy Body descends in the first Second of Time after its beginning to fall, very near 16 Feet.

*An Example to find the Depth of a Well may serve for all.*

Suppose you hang up a short *Pendulum*, that will vibrate Quarter Seconds, (the way to find its Length hath already been shewn) and letting go the Stone and the *Pendulum* together, you find the *Pendulum* hath made 16 single Vibrations before you hear the Noise of the Stone's fall into the Water. Then since 16 Quarters of a Second are equal to four Seconds, if you account the Acceleration of the Descent of heavy Bodies to be either as the Squares of the Times, or as the Encrease of the odd Numbers, either way will give you the Number 256 for the Depth of the Well.

For since, as it is elsewhere shewn, a Body descends 16 Feet in the first Second of Time, in the fourth Second it will descend 16 times 16 Feet; for the Times being 1 and 4, the Descent will be as their Squares; that is, as 1 to 16: Wherefore Multiplying 16 by 16, you have 256, the Depth of the Well.

Or, if according to *Galileus's* way, you account 16 Feet for the first Second, and then 3 times 16 for the next Second, 5 times 16 for the third Second, and 7 times 16 for the fourth Second; all these Numbers added together, will make 256, the Depth as before.

Indeed some Abatement must be allowed for the Time the Noise of the Stone's fall into the Water takes to reach the Ear. Wherefore since a Sound moves 968 Feet in a Second, and 256 is a little more than  $\frac{1}{3}$  of that Number, a little more than  $\frac{1}{3}$  of 16 Foot must be taken out of the former found Depth 256. So that the Depth of the Well may be roundly accounted 250 Feet.

But in the other Estimations of the Distance of a Cloud, Ship, or Fort, there needs no such Allowance; and the bare Multiplication of 968, by the Number of Seconds between the Flash and the Report, will give the Distance of the Cloud or Ship from the Observer.

That Night, (*viz.* April 12.) on which our late Mighty Monarch King *William* was buried, we counted oftentimes very accurately, That the Distance between seeing the Flash, and hearing the Report of the Tower Guns, (which were then fired very solemnly and distinctly) was always 7 Seconds of Time. Multiplying then 968 by 7, it produces 6775, which is to be accounted the Distance between *Amen-Corner* and the Tower of *London*; which is one Mile, and 1495 Feet, or something more than a Mile and a Quarter.



**PENDULUMS** *Royal*, are those Clocks whose *Pendulum* swings Seconds, and goes eight Days, shewing the Hour, Minutes, and Seconds.

The Numbers of such a Piece are calculated thus :

First, Cast up the Seconds in 12 Hours, and you'll find them to be  $43200 = 12 \times 60 \times 60$ . The Swing-wheels must needs be 30, to swing 60 Seconds in one of its Revolutions: Now let  $\frac{1}{2} 43200 = 21600$  be divided by 30, and you'll have 720 in the Quotient, which must be broken into Quotients; the first of them must be 12 for the Great Wheel, which moves round once in 12 Hours. 720 divided by 12, gives 60, which may also be conveniently broken into two Quotients, as 30 and 6, or 5 and 12, or 8 and  $7\frac{1}{2}$ ; which last is most convenient: And if you take all your Pinions 8, the Work will stand thus:

8)	96	(12
8)	64	(8
8)	60	(7 $\frac{1}{2}$
<hr/>		
	30	

According to this Computation, the Great Wheel will go about once in 12 Hours, to shew the Hour, if you will; the Second Wheel once in an Hour, to shew the Minutes; and the Swing-Wheel once in a Minute, to shew the Seconds.

**PELLICAN**, is the Chymists Term for a kind of Double Vessel, used in Circulations. See *Double Vessels*.

**PELLICLE**, a little Skin. When any Solution in Chymistry is in a gentle Heat evaporated so long till a thin Skin or Film arise on the top of the Liquor, 'tis call'd an *Evaporation to a Pellicle*; and then there is very little more Liquor left than what will just serve to keep the Salts in Fusion.

**PELVIS**, is the Place at the Bottom of the Belly, wherein the Bladder and Womb are contained.

**PENNATA folia**, *winged Leaves*, is a Term among the Botanists, for such Leaves of Plants as grow directly one against another on the same Rib or Stalk; as those of *Ash*, *Walnut-Tree*, &c.

**PELVIS Aurium**. See *Cochlea*.

**PELVIS Cerebri**. See *Choana*.

**PELVIS Renum**, is a Membranous Vessel or Receptacle in either Kidney, which receives the Urine, and pours it into the Bladder.

**PEMPHIGODES Febris**, [*πεμφιγώδης* of *πέμφω* *a blast*, *a drop*] is a Spotted Fever; some say a Windy or a Flatulent Fever.

**PENETRATION of Dimensions**, is a Philosophical way of expressing, That two Bodies are in the same Place, so that the Parts of one do every where penetrate into, and adequately fill up the Dimensions or Places of the Parts of the other; which is manifestly impossible, and contradictory to Reason.

**PENINSULA**, in Geography, is a Portion of Land, which being almost surrounded with Water, is joined to the *Continent* only by an *Isthmus*, or narrow Neck of Land; as *Africa*, the greatest *Peninsula* in the World, is joined to *Asia*; that of *Morea* to *Greece*, &c.

**PENIS**, [in *Anatomy*] a Part of the Body, which from its Form is also call'd the *Yard*, and by way of Evidence the *virile* Member, as being one of the principal Organs of Generation in the Male-kind.

**PENNY**, *Denarius*, was the first coined piece of Silver we have any account of; and for many Years the only one. In the Reign of *H. 1.* there were Half-pence. A Penny was so much the whole of the current Coin of the Kingdom, that *Denarius* signified the same thing with *Nummus* or Money. Dr. *Hickes* in his *Dissertatio Epistolaris*, p. 109. saith, that the *Anglo-Saxons* had but one Silver Coin amongst them, and that was a *Penny*; and *Cambden* and *Spelman*, and most of our good Antiquaries agree in this. The old *Penny* before 1279 was struck with a double Cross, so that it might easily be broken in the middle, or into four Quarters; and so made into *Half pence* or *Farthings*, saith Mr. *Stow*; on which it was then ordered, that Half-pence and Farthings should be made or coined round, as the *Penny* was before. The *Penny* was called *Sterling*, which see.

**PENNY-Weight**, formerly every Pound contained 12 Ounces, and each Ounce was divided into 20 parts, called *Twenty-penny-weight*; for then *Twenty-penny-weight* weighed an Ounce: and tho' the *Penny-weight* be altered, the Denomination still continues.

**PENSA**; formerly there were three ways of paying a Pound of Money into the Exchequer. 1. Payment of a *Pound de Numero*, which was just 20 Shillings in Tale. 2. Payment of a *Pound ad Scalum*, which was 6 d. over and above the 20 s. 3. *Ad Pensum*, which was paying the full Weight of 12 Ounces.

**PENSION**, that which in the two *Temples* is called a *Parliament*, and in *Lincolns-Inn* a *Council*, is in *Gray's-Inn* termed a *Pension*: That is, An Assembly of the Members of the Society, to consult of the Affairs of the House. Also in the Inns of Court, *Pensions* are certain annual Payments of each Member to the House, for certain Occasions.

**PENSION Writ**, when a *Pension Writ* is once issued, none sued thereby in the Inns of Court shall be discharged, or permitted to come into Commons, till all Duties be paid.

**PENSION Order** in *Grays-Inn*, seems to be a peremptory Order against such of the Society as are in Arrear for *Pensions*, and other Duties.

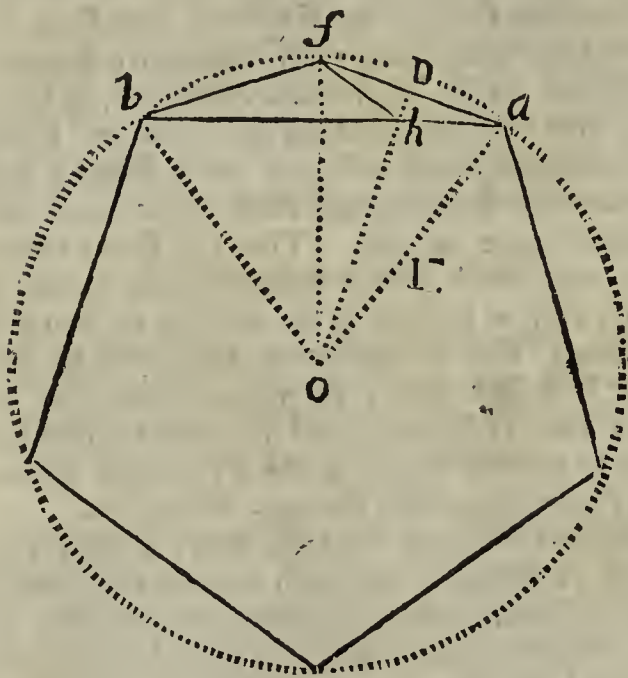
**PENTAMETER** [*πεντάμετρον* of *πέντε* and *μέτρον*, Gr. *measure*] a kind of Verse consisting of 5 Feet, the two first may be either Spondees or Dactyls, the third always a Spondee, and the two last Anapests.

**PENTAGON**, in Geometry, is a Figure having five Sides, and five Angles: If all the Sides are equal, and consequently the Angles, 'tis called a *Regular Pentagon*.



PROPOSITION.

The Side  $a b$  of a Regular Pentagon, or which can be inscribed in a Circle, is in Power equal to the Side of an Hexagon and Decagon inscribed in the same Circle: That is, The Square of  $a b$ , is equal to the Sum of the Squares of  $a f$  and  $a o$ .



Let  $a o$ , the Side of the Hexagon, be called  $H$ ; and  $a f$  (that of the Decagon) be called  $D$ ; and  $a b$  be called  $P$ .

$$[I \text{ say } PP = HH \times DD.]$$

For the Angle at the Centre  $b o a$  being 72 Degrees, the equal ones,  $b$  and  $a$ , in the same Triangle, must be 54 Degrees each. Bisect then the Angle  $f o a$  by the Prick'd Line  $o b$ ; and then 'tis plain the Angle  $b o b$  will also be 54 Degrees, (*i. e.* 36 + 18 Degrees,) and consequently the  $\triangle a b o$  and  $o b b$  are similar. Wherefore  $a b : b o :: b o : b b$ : (*i. e.*) in

$$\text{our Notation, } P : H :: H : \frac{HH}{P}.$$

Again, In the  $\triangle b f a$ , the Angles  $b$  and  $a$  are =; and also in the little  $\triangle f b a$ , the Angle  $f = a$ ; and consequently the 2  $\triangle a b f$  and  $f b a$ , are similar; and consequently  $b a : a f :: a f : a b$ . That is,  $P : D :: D : \frac{DD}{P}$ .

Wherefore of the whole Line  $b a$ , the 2 Parts are found to be by this Notation,  $\frac{HH}{P}$  and  $\frac{DD}{P}$ .

That is, the whole is  $\frac{HH + DD}{P}$ , but this Line  $a b$  is =  $P$ : Wherefore  $PP = HH + DD$ . Q. E. D.

PENTANGLE, [of πέντε, Gr. five and angulus L. a Corner] a Figure having five Angles.

PENTAPTOTES, (in Grammar,) are such deficient Nouns as have but five Cases, as *Nemo*.

PENTASTYLE [πεντάστυλον of πέντε and στήλη, Gr. a Column] a Building where there are 5 Rows of Columns.

PENTECOSTALS, were, and are still in some few Dioceses; Whitfun-Contributions paid to the Bishops, of which probably the first Occasion were

certain pious Oblations made to the Cathedral Church at *Pentecost* or *Whitfontide*. They were also made by the *Parishioners* to their *Parish Priest*, and sometimes by inferior Churches or *Parishes* to their Mother-Church. These *Parish Pentecostals* were called *Whitson-Farthings*, and their Sum was divided into four parts, of which one went to the Priest, one to the Poor, one towards the Repair of the *Parish-Church*, and one to the Bishop. See *Stephens of Procurations and Pentecostals*, and Dr. Kennet's *Parochial Antiquities in Glossary*.

PENUMBRA [in Astronomy] a faint or partial Shade observed between the perfect Shadow and the full Light in an Eclipse.

PERACUTUM *Menstruum*. See *Menstruum Peracutum*.

PERAMBULATION of the Forest, is the Surveying or Walking about the Forest, or the Limits of it, by Justices, or other Officers thereto appointed, to set down the Metes and Bounds thereof, and what is within the Forest, and what without.

PERAMBULATIONE facienda, is a Writ that is sued out by two or more Lords of Mannors lying near one another, and consenting to have their Bounds severally known. It is directed to the Sheriff, commanding him to make *Perambulation*, and set down their certain Limits.

PERAMBULATOR, or *Walking-Wheel*, is an Engine made of Wood or Iron, commonly half a Pole in Circumference, with a Movement, and a Face divided like a Clock, with a long Rod of Iron or Steel, that goes from the Centre of the Wheel to the Work: There are also two Hands, which (as you drive the Wheel before you) count the Revolution; and from the Composition of the Movement, and by the Division on the Face, shew how many Yards, Poles, Furlongs, and Miles, you go. The Use of this Instrument is to measure Roads, Rivers, and all Level Lands, with great Expedition.

PER *Arfin*, PER *Thefin*, [in Musick] signifies by beating, or during the last Time of the Measure or rising, the first time of the Measure or Position.

PERAVAYLE. See *Paravayle*.

PERCEPTION, is the clear and distinct Apprehension of any Objects offered to us, without forming any Judgment concerning them.

PERCH, *Pertica*, is an *English* Measure of 16 Foot and a half in Length, called also a Pole and Rod. Forty such Perches in Length, and four in Breadth, make what we call an *Acre of Ground*. This is the common *Statute-Perch*; but in some Counties in *England* its Length is different; as in *Staffordshire* it is 24 Foot, in the Forest of *Sherwood* 25 Foot. In *Herefordshire*, tho' a *Perch* of Walling be but 16  $\frac{1}{2}$  Feet, yet a *Perch* of Ditching is 20 Feet: In the Forest of *Canke* 'tis 25; in the Forest of *Clarendon* 20. *Skene de Verborum significatione sub verb. Perticata Terræ*, saith, *Perticata Terræ* is a Rood of Land. There are also some other Measures mentioned which are now out of use. He saith three Feet and one Inch make an *Elne*; six *Elnes* make a *Fall*; which he saith is the common lineal Measure. Six *Elnes* long and six broad make a *Square*, and *Superficial Fall* of Land measured; and 'tis to be understood, he saith, that a *Raip*, a *Rod* and a *Lineal Fall* of Measure, are all one; only a Rod is a *Staff* or *Pole* of Wood, and



a *Raip* is made of *Tow* or *Hemp*. Also ten *Falls* in Length and four in Breadth make an Acre : This is the Measure of *Scotland*.

PERDONATIO *utlagariæ*, is a Pardon for him who, for Contempt in not coming to the King's Court, is out-law'd, and afterwards of his own Accord, yieldeth himself to Prison.

PEREMPTORY, in Law, signifies a final and determinate Act, without Hope of renewing or altering.

PEREGRINE, [in *Astrology*] a Term apply'd to a Planet, when found in a Sign where it has none of its essential Dignities.

PERRENNIAL, [in *Botany*] an Epithet apply'd to *Ever-Greens*, or such Plants as preserve their Leaves and Verdure all the Year.

PERFECT *Concords*, in Musick. See *Concords*.

PERFECT *Fifth*, the same with *Diapente*; which see.

PERFECT *Flowers*, [in *Botany*] are such as have Petals, Pistil, Stamina and Apices.

PERFECT *Numbers*, are such whose aliquot or even Parts, join'd together, will exactly return the whole Number, as 6, 28, &c. For of six, the half is three, the third Part two, and the sixth Part one, which added together, make six; and it hath no more aliquot Parts in whole Numbers: So twenty eight, which has these Parts, *viz.* 14, 7, 4, 2, and 1, exactly return 28; which therefore is a Perfect Number, whereof there is but ten between one and one Million of Millions.

PERFORANS, is a Muscle of the Fingers, so called because its Tendons run thro' those of the *Perforatus*; it's also called *Profundus* from its Situation; and *Tertii Internodii Digitorum Flexor*, from its Use. It riseth fleshy from near two Thirds of the Superior and Forepart of the *Ulna*, as also from the Ligament between the last named Bone and the *Radius*; and becoming a large thick belied Muscle, grows outwardly Tendinous, before it passeth over the *Pronator Radii Quadratus*, and is divided into four round Tendons, which march under those of the *Perforated* Muscle, beneath the *Ligamentum Transversale*; from each of these Tendons the *Musculi Lumbricales* are said to arise, after which they pass thro' the *Fissures* of those of the *Perforated* Muscles, and proceeding over their Extremities, terminate in the Superior and Forepart of the third Bone of each Finger.

The Tendons of this Muscle running through those of the *Perforated*, is a no less useful than stupendous Artifice in Nature. For to the End the Fingers (like so many Leavers) should be bended with great Force, it is absolutely necessary the strongest Muscle should be inserted nearest their Extremities, and farthest from their *Fulcimenta* the *Offa Metacarpi*: But in regard every Internode should be attended with a particular Muscle, the better to accommodate them to various Employments, and the Origination of the Superior or *Perforatus*, is confined to the *Apex* of the Internal Extubérance of the *Os Humeri*, and upper Part of the *Radius* only; wherefore could not be a fit Instrument for so strenuous an Action, and that not only in regard to its Magnitude, but by the Approach of its two Extrems when the *Cubit* or *Carpus* are bended; both which would be no small Impediments in divers Actions; it's therefore necessary it should be employed in the Motions of the second Internodes: But since these Superior

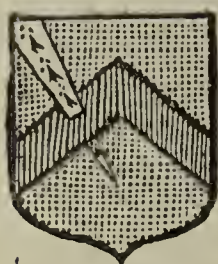
Tendons would be hereby liable to interrupt the Inferior in their right Progress to the Extremities of the Fingers; it seems an Argument of great Counsel in transmitting the latter through the Fissures of each of the former, whereby the Actions of both are not only distinctly performed, and the Extremities of the Fingers attended with the largest Muscle, (whose Origin is below the *Os Humeri*, wherefore its Extrems cannot approach in the Flexion of the *Cubit*,) but their Motions are preserved, tho' the Superior Muscle is totally divided; which indeed is a provident Contrivance of the Author of Nature, and is in it self sufficient to excite our Admiration.

PERFORANS, a Muscle of the lesser Toes; so called, because its Tendons run thro' the Fissures in the Tendons of the *Musculus Perforatus Pedis*: It is also called *Flexor tertii Internodii Digitorum Pedis*, from its Use. It hath an acute fleshy Origination from the Back-part of the *Tibia*, immediately under the *Musculus Subpopliteus*, having a double Order of Fibres united in a middle Tendon like the *Flexor Pollicis Longus*, but ceaseth to be Fleshy as it passeth behind the *Malleolus Internus*, and running in a Channel over the Internal Part of the *Os Calcis*, under it, Imbanding Ligaments in half its Progress thro' the Sole of the Foot; it is divided into four Tendons, which march thro' the Perforations of the Tendons of the *Perforatus Pedis*, and are inserted to the third Bone of every lesser Toe.

PERFORATUS, is a Muscle belonging to the Fingers; and so called, because its Tendons are Perforated to admit those of the *Perforating* Muscles to pass thro' them to their Insertions: It is also called *Sublimis*, from its Situation, being above the *Perforating* Muscles; and *Flexor secundi Internodii Digitorum*, from its Use: It riseth Tendinous from the Internal Extubérance of the *Os Humeri*, between the *Flexores Carpi*: It also has a disgregated Fleshy Origination from the Fore part of the *Radius*, between the *Pronator Radii Teres* and *Flexor Pollicis Magnus*, composing a Fleshy Belly, lessens it self in less than half its Progress, where it's divided into four Fleshy Portions, each of which soon becomes so many roundish Tendons, which are included in their proper Mucilaginous Membrane as they pass under the *Ligamentum Transversale Carpi* thro' the Palm; near the first Internode of the Fingers each Tendon is divided to admit those of the *Perforated* Muscle thro' them; then joining and subdividing again immediately before they are inserted to the Superior Part of the second Bone of each Finger.

PERFORATUS *Pedis*, is a Muscle of the lesser Toes; so called, because its Tendons are Perforated like those of the Fingers. It is also called, *Flexor secundi Internodii Digitorum Pedis*, from its Use; and *Sublimis* from its Situation. It springeth from the Inferior and Internal Part of the *Os Calcis*, between the *Musculi Abductores* of the greater and lesser Toes, dilating it self to a Fleshy Belly: After it hath passed the Middle of the *Planta Pedis*, it is divided into four Fleshy Portions, which becoming so many Tendons, are divided near their Terminations, to admit the Tendons of the *Perforans* to pass thro' them to their Insertions: These being united again, pass underneath them to their Implantations at the upper Part of the second Bone of each lesser Toe.





PERFORATED, *i. e.* bored thro'. The Armorists use it to express the passing or penetrating of one Ordinary (in part) thro' another; as thus:

He beareth *Or*, a bend *Ermine Perforated thro' a Chevron Gules*. But when there is only a Hole made thro' the Ordinary, and

nothing in it to fill it up, they call it *Piercing*.

PERIAMMA, [περίαμμα, Gr.] called also *Periapta*, is a Medicine, which being tied about the Neck, is believed to expel Diseases, especially the Plague. See *Appensa*.

PERIANTHEUM, [of περί about and ἄνθος, Gr. a *Flower*,] a Term that Botanists give to those little green Leaves, which compass the Bottom of the Flower; the same that Dr. *Grew* calls the *Empalement*, and others the *Calyx*.

PERIAPTUM. *Vid. Periamma*.

PERICARDIARY, [in *Medicine*] an Epithet given to those Worms that are generated about the *Pericardium* or *Capsula* of the Heart.

PERICARDIUM, [περικάρδιον of περί about and καρδιά, Gr. the *Heart*] is a double Membrane which surrounds the whole Substance of the Heart, and contains a Liquor to Moisten, Lubricate, and, as some say, to Refrigerate the Heart: It hath five Holes, according to the Number of Vessels which go out of the Heart. It adheres to the *Mediastinum* at the Basis, and at the *Mucro* to the Centre, or Nervous Part of the *Diaphragma*.

PERICARDIUM. Dr. *Keil* in *An. Secretion*, p. 32, 33. shews, that the Liquor in the *Pericardium* is the most fluid of any that is separated from the Blood; because the Particles of it unite first, and are secreted first; and those Particles which unite first will have the greatest attractive Force; and such must have their Corpuscles of a most spherical Figure, and must be most solid; so that their Contact will be the least that can be.

PERICARPIUM, [περικάρπιον] is a Medicine applied to the Wrists to cure an *Ague*, &c.

PERICARPUS, [of περί about, and καρπός, Gr. *Fruit*] a thin Membrane or Pellicle, which incompasses the Fruit or Grain of a Plant.

PERICRANIUM, [περικράνιον of περί and κράνιον, Gr. the *Skull*] is a Membrane which infolds the Skull, seated next to the *Periosteum*, covering the whole Skull, except just where the Temporal Muscles lie. It is of exquisite Sense; and causes intolerable Pain when the Temporal Muscle is wounded.

PERIGÆON, [περιγαίον of περί and γῆ, Gr. the *Earth*] or *Perigæum*, is a Point in the Heavens, wherein a Planet is said to be in its nearest Distance possible from the Earth.

PERIHELION, [περιήλιον of περί and ἥλιος, Gr. the *Sun*] is that Point of a Planet's Orbit, wherein it is nearest to the Sun.

PERIMETER, [περίμετρος, Gr.] is the Compass or Sum of all the Sides which bound any Figure, whether *Rectilineal* or *Mix'd*.

PERINDE *Valere*, a Term belonging to the *Ecclesiastical Law*, signifying a Dispensation granted to a Clerk, that being defective in his Capacity to a Benefice, or other Ecclesiastical Function, is *de Facto* admitted to it: And it hath the Appel-

lation from the Words, which make the Faculty as effectual to the Party dispensed with, as if he had been actually capable of the Thing for which he is dispensed with at the Time of his Admission. It is called a *Writ*.

PERIOD [in *Astronomy*] the Time which a Planet or Star takes up in making a Revolution; or the Duration of its Course, till it return to the same Point of the Heavens.

PERIOD, is a Full-stop at the End of any Sentence. A *Period* in Numbers, is a Distinction made by a Point or Comma after every sixth Place or Figure; and is used in *Numeration* for the readier distinguishing and naming the several Figures or Places: Which how to do, see under *Numeration*.

PERIOD, in Chronology, signifies a Revolution of a certain Number of Years; as the *Metonick Period*, the *Julian Period*, and the *Calippick Period*: Which see in their proper Places.

PERINÆUM, [περίναιον, Gr.] is the Ligamentous Seam betwixt the *Scrotum* and the *Fundament*.

PERIODICAL, is the Term for whatever performs its Motion, Course, or Revolution, regularly, so as to return again, and to dispatch it always in the same Period or Space of Time. Thus the *Periodical Motion* of the Moon, is that whereby she finishes her Course round about the Earth in a Month; and this is in 27 Days, 7 Hours, 45 Minutes; and is called, The Moon's

PERIODICAL *Month*; which is the Space of Time that the Moon finishes her Revolution in.

PERIODICK *Diseases*, are such as decline and rise again with similar Symptoms alternately.

PERIODUS *Sanguinis*, is a continued Circulation of the Blood thro' the Body; which is thus made: The Blood is carried out of the Arteries by Fibres, either of the Flesh or of the Entrails, or the Membranous Parts, saith *Blanchard*; but 'tis certain it is by Capillary Arteries continued with the like small Veins into the Mouth of the greater Veins, and implanted in them, as we see many other little Channels in the Veins; so the Blood, passing thro' these out of the Arteries, is presently sent to the Veins, that it may be carried back again to the right Ventricle of the Heart; and thence by the Arterious Vein to the Lungs; in which after the Blood has been accended by some Nitrous Particles, breathed in thither by the Air, it goes into the Venous Artery, thence into the left Ventricle of the Heart; which again empties it self into the *Aorta*, or Great Artery; so that the Body may be nourished and enlivened, it goes into every Part of it. This is *Blanchard's* Account of the Matter. See more in the Word *Circulation of the Blood*.

PERIOECI, [περίοικοι of περί and οἰκῶ, Gr. to dwell] a Name given by Geographers to those Inhabitants of the Globe as have the same Latitudes, but opposite Longitudes; or live under the same Parallel, and the same Meridian but in different Semi-circles of that Meridian. They have the same common Seasons throughout the Year, and the same *Phænomena* of the heavenly Bodies; but their Hours or Times of the Day are opposite to each other, *i. e.* it is Midnight with the one, at the same Time it is Mid-Day with the other.



**PERIOPHTHALMIUM**, [of *περὶ* about, and *ὀφθαλμῶ*, Gr. *the Eye*] is a thin Skin which Birds can draw over their Eyes to defend them, without shutting their Eye-lids. The same with the *Membrana Nictitans*.

**PERIOSTEUM**, [*περίοστέον* of *περὶ* and *ὀστέον*, Gr. *a Bone*] is a thin Membrane that incloses immediately almost all the Bones in the Body, except the Teeth, Bones of the Ear, &c. It hath a most exquisite Sense, and probably is an *Expansion* of the Nervous and Tendinous Fibres of the Muscles. Its Use is to cover the Bones, and to sustain the Vessels which enter into them to nourish them. Dr. *Havers* in his Excellent Book, called, *Osteologia Nova*, saith, That this Membrane consists of two Sorts of Fibres, of which those that lie next the Bone, are derived from the *Dura Mater*, and the others from the Tendons of the Muscles.

**PERIPATETICK**, [of *περιπατέω*, Gr. *to walk about*] *Philosophy*, is named from those, who from their Action of Walking while they Studied or Taught were called,

**PERIPATETICKS**. The Chief of these was *Aristotle*; then his Successors; among whom you may reckon *Theophrastus*, *Cratippus*, *Boethius*, and all his very numerous Interpreters. But about 460 Years ago, there arose a new Set of Famous *Aristotelians*, which were called also *Peripateticks*; from them came the three chief Sects of the *Peripatetick Philosophy*. The *Thomists* from *Thomas Aquinas*, who flourished A. D. 1224. The *Scotists* from *Johannes Dun Scotus*, A. D. 1308. And the *Nominalists* from *Ocham*, who was born about A. D. 1310. And now a days by the *Peripatetick Philosophy*, we understand that which was founded on the Principles of *Aristotle* and his Commentators and Followers; and which therefore is as frequently called, *The Aristotelian Philosophy*.

**PERIPHERY**, [*περιφέρεια*, Gr.] in Geometry, is the Circumference of a Circle, or any other Regular Curvilinear Figure.

**PERIPHRAISIS**, [*περίφρασις*, Gr.] is a Circumlocution used to avoid certain Words, whose Ideas are displeasing; and to prevent the speaking of something that would produce ill Effects.

**PERIPNEUMONIA**, [*περιπνευμονία* of *περὶ* and *πνεύμων*, Gr. *the Lungs*] is an Inflammation of the Lungs and Breast, accompanied with a sharp Fever, hard Breathing, a Cough, and an heavy Pain. *Blanchard*.

**PERIPNEUMONIA Notha or Spuria** [in *Physick*] a Disease of the Lungs, proceeding from a ponderous pituitous Matter generated throughout the whole Mass of Blood, and discharg'd upon the Lungs.

**PERIPTERE**, [of *περὶ* and *πτερόν*, Gr. *a Wing*] in Architecture, is a Place encompassed round with Columns, and with a kind of Wings about it; here the Pillars stand without, whereas in the *Peristyle* they stand within.

**PERISCHII**, [*περίσκιτοι*, Gr.] are the Inhabitants of the two Frozen Zones, or those that live within the Compass of the *Arctic* and *Antarctic* Circles; for as the Sun never goes down to them after he is once up, but always round about, so do their Shadows. Whence the Name.

**PERISSOLOGY**, [*περισσολογία* of *περισσός*, *abounding*, and *λόγος*, Gr. *a Word*] is a Discourse fill'd up with unnecessary and superfluous Words.

**PERISTALTICK Motion**, *περισταλτικός* of *περιέλλω*, Gr. *to roll about*] is a *Vermicular* or *Worm-like* Motion of the Intestines, whereby the Excrements are voided. Also the Motion of the Vessels, whereby Humours, as Water, Chyle, the Blood, &c. ascend and descend, is sometimes so called.

**PERISTAPHILINUS**, *internus* & *externus*, are Muscles of the *Uvula*, the one pulling it forwards, and the other backwards.

**PERISTERNA**, in Anatomy, are the lateral parts of the *Thorax*.

**PERISYSTOLE**, [of *περὶ* about, and *συστολή*, Gr.] the Pause or Interval between the two Motions of the Heart or Pulse, *viz.* that of the *Systole* or Contraction, and that of the *Diastole* or Dilatation.

**PERISTYLE**, [*περιστυλίον* of *περὶ* and *σύλη*, Gr. *a Column*] in Architecture, is a Place or Building encompass'd with Pillars, standing round about within the Court: But this Word *Peristyle* is sometimes taken for a Row or Rank of Columns, as well without as within any Edifice; as in Cloysters and Galleries: Sometimes this was called *Antiprostyle*.

**PERITONÆUM**, [*περιτόναιον* of *περιτείνω*, Gr. *I stretch all round about*] is a Membrane (of an Oval Figure) which clothes the whole *Abdomen* on the Inside, and its Entrails on the Outside: It consists of two Tunicks, and adheres above to the *Diaphragma*, below to the *Os Ilium*; before to the Transverse Muscles, but chiefly to their Tendons about the *Linea Alba*; behind, it grows to the Flethy Heads of these Muscles.

**PERITONÆUM**: [*περιτόναιον*, Gr.] The external Surface of this soft thin Membrane is unequal where it adheres to the transverse Muscles; the internal is very smooth. It hath a Number of small Glands which separate a Liquor which supplies the Intestines, and facilitates their Motion; and when these Glands are obstructed the *Peritonæum* grows thick, as in several Dropsies. The *Peritonæum* is a double Membrane, containing in its Duplication the Umbilical Vessels, the Bladder, Ureters, Kidneys, and Spermatick Vessels, to all which it gives a Membrane, as also to the Liver, Spleen, Stomach, Intestines and Womb.

Its external *Lamina* hath two Productions, like to two Sheaths, which pass thro' the Rings of the oblique and transverse Muscles in the Groin, for the passage of the Spermatick Vessels in Men; and for the round Ligaments of the Womb in Women. These Productions being come to the Testicles in Men, dilate and form the *Tunica Vaginalis*. The Internal *Lamina*, which is very thin here, having accompanied the external Productions a little way, cleaves close to the Spermatick Vessels and round Ligaments of the Womb. The *Peritonæum* hath Veins and Arteries from the *Phrenicæ*, the Mammary, the Epigastrick, and often from the Spermaticks. Its Nerves are of those which are distributed in the Muscles of the *Abdomen*; it hath likewise a few Lymphaticks which discharge themselves into the *Iliack Glands*. By the Elasticity of its Fibres it easily dilates and contracts in Respiration, and in Conceptions. If it breaks it causes a Rupture either in the Navel or Groin. Its Use is to contain the Bowels of the *Abdomen*, and to give to each of them an outer Coat.

**PERITRO-**



**PERITROCHIUM**, [*περιτρόχιον* of *περιτρέχω*, Gr. *I run about*] in Mechanicks is a kind of Wheel, or Circular Frame of Wood, placed somewhere upon an Axis, or Cylinder, round which a Rope is wound, in order to raise a Weight; and the Use of this *Peritrochium*, is to make the Cylinder or Axis be turned the more easily by the Means of Staves or Levers, which are fix'd in its Circumference. See *Axis* in *Peritrochio*.

**PERJURY**, is a Crime committed, when a lawful Oath is administred by any that hath Authority, to any Persons in any Judicial Proceedings; who swear absolutely and falsely in a Matter material to the Issue or Cause in Question, either of their own Accord, or by the Subordination of others. *Note*, If a Man call me *Perjured Man*, I may have my Action upon the Case; but for calling me a *Forsworn Man*, no Action lies. And *Perjury* is excepted out of the Act of *General Pardon*.

**PERMEATING**, is penetrating into, and passing thro' the Pores of any Body. Mr. Boyle had a *Smoaking Liquor*, which he called, *The Permeating Menstruum*, and its Operations, *The Penetrant*, or *Permeating Fumes*. It was made of equal Parts of *Flos Sulphuris*, *Sal Armoniack*, and good Quick Lime, all Powdered, and well mingled together, and then distilled by Degrees of Fire in a Retort, till the Sand which contains the Retort, became almost red-hot; for then will come over a Liquor which will be continually smoaking, and consequently must be kept well stop'd. With this Fuming Liquor he made several Experiments to evince the Porosity of Bodies; by discovering, that tho' Coins, &c. were wrap'd up close in Leather, &c. yet the Fumes of this *Permeating Menstruum* would get thro' them, and discolour the Metal. *Vid. Eff. of Porosity of Body*, p. 36, 37.

**PER MINIMA**, a Term used in Chymistry and Physick, expressing the perfect Mixture of any two or more Bodies: *v. gr.* If Silver and Lead be melted together, they will mingle and be united with one another *per minima*: That is, all the smallest Particles of one Metal will be mingled and united with those of the other.

**PERMUTATION** of Quantities. See *Variation* and *Combination*.

**PERMUTATIONE** *Archidiaconatus & Ecclesiæ eidem annexæ cum Ecclesia & præbenda*, is a Writ to an Ordinary, commanding him to admit a Clerk to a Benefice, upon Exchange made with another.

**PER** *my & per toute*, in Law, a Joint-Tenant is said to be seised of the Lands that he holds jointly *Per my & per tout*; that is, he is seised by every Parcel, and by the whole.

**PERNANCY**: Taking or receiving Tythes in Pernancy, is taking such as are or may be paid in kind.

**PERNICITY**, a Word used by some Philosophick Writers for *Celerity*, or extraordinary swiftness of Motion.

**PERNIO**, is a preternatural Swelling, caused by the Winter Cold, especially in the Hands and Feet, which at last breaks out.

**PERONA**, is also called *Fibula*, because it joins the Muscles of the Leg; whence the first and second Muscle in the Leg is called *Peronæus*.

It is the less and slender Bone, which is fastened outwardly to the greater Bone of the Leg, called *Tibia*.

**PERONÆUS** *primus*, [of *περόν*, Gr.] a Muscle of the *Tarsus*, by some it is called *Longus*, it being the first that offers it self to view, and the longest Muscle seated on the *Fibula* or *Os Peronæ*.

It arises Externally Tendinous, and Fleishy Internally from above half the Superior part of the said Bone, and marching somewhat backwards becomes a strong, flat Tendon, four Fingers breadth in length above the Inferior Appendage of the said *Fibula*, called *Malleolus Externus*; passing behind which in a Channel, like a Rope in a Pulley; and from thence being inflected forwards, together with the Tendon of the following Muscle, they pass under an imbanding Ligament as they run over the *Os Calcis*, but this Tendon declining from its Companion, marches over the *Os Cuboides*, under the *Musculus Abductor Minimi Digiti*, and over the *Ossa Cuneiformia*, in the Bottom of the Foot, and under the Tendons and Muscles bending the Toes, and is inserted to the Superior and Hindmost part of the *Os Metatarsi* of the Great Toe. The Tendon of this Muscle being conveyed over the Hindmost part of the *Malleolus Externus*, as on a Pulley, is an elegant Contrivance in Nature, whereby the Ball of the Great Toe (as that part is commonly called to which it is inserted) is directed towards a Perpendicular bearing of the Weight of the Body on the Leg, in standing on Tip-toe, by pulling the Foot and Toes somewhat outwards.

**PERONÆUS** *secundus*, a Muscle of the *Tarsus*, by some called *Semi-fibulans*: It has an Acute Fleishy beginning above the middle of the External part of the *Fibula*, under the Fleishy Belly of the *Peronæus primus*; it also continues its Fleishy beginning from the Posterior sharp edge of the said *Fibula*, and becoming a Fleishy Belly, grows Tendinous, as it runs under the *Malleolus Externus*, together with the Tendon of the *Peronæus primus*, and is Inserted to the Superior and External part of the *Os Metatarsi* of the Little Toe. The proper Action of this Muscle is to pull the Foot and Toe outwards.

**PERPENDICULUM** *Chronometrum*, the same with the *Pendulum*.

**PERPETUAL** Motion; by this Term ought to be meant an uninterrupted Communication of the same Degree of Motion from one part of Matter to another, in a Circle, (or such like Curve returning into itself) so that the same Quantity of Matter shall return perpetually undiminished upon the first Mover: And perhaps if Men had rightly understood that this is the true meaning of a perpetual Motion, abundance of Expence both of Money and Reputation might have been saved by the vain Pretenders to this piece of impossible *Mechanism*. For since by the second Law of Nature or Motion, (see Motion) *The Changes made in the Motions of Bodies are always proportional to the impress'd moving Force, and are produced in the same Direction with it*, no Motion can be communicated to any Engine or Machine greater than that of the first Force, impressed, and therefore since on our Earth all Motions performed in a Fluid which resists them, it must of Necessity retard them; and consequently a considerable Quantity of the Motion must be spent upon the resisting Medium; so that 'tis impossible

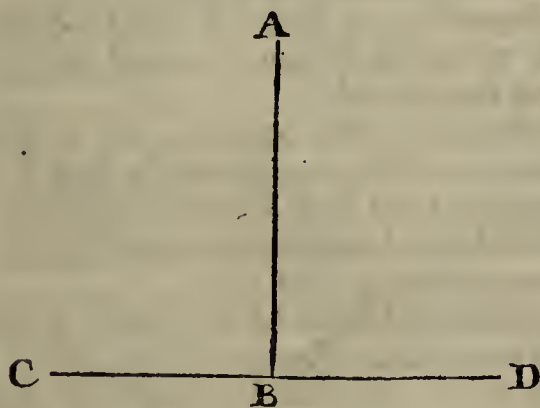


possible the same Quantity of it can return undiminish'd on the first mover; which yet is absolutely necessary for the Continuance of the same *Motion* perpetually. Besides, in no *Engine* or *Machine* whatsoever, can all *Friction* be avoided, there being in Nature no such thing as exact Smoothness or perfect Congruity: The manner of the Cohesion of the Parts of Bodies, the small Proportion the solid Matter bears to the Vacuities between them, and the Nature of those constituent *Particles* not admitting it; wherefore this *Friction* will also sensibly in time diminish the impressed or communicated Force, so 'tis not possible the *Motion* can be perpetual; which Effect can indeed never follow, unless the communicated Force be so much greater than the generating Force, as to recompense the Diminution made therein by all these Causes, in order to the *Motion's* returning undiminished upon the first Mover. But *nil dat quod non habet*, the generating Force cannot communicate a greater Degree of *Motion*, than it hath it self, and consequently, the perpetual *Motion* is demonstratively impossible.

Besides, it being certain that a Body cannot move constantly in any Orbit with the same Degree of *Motion* from one single Impulse; since that Degree of *Motion* and *Velocity* arising from such a single Impulse, must by that means continually decrease, and so at last be quite spent and extinct: From hence it will follow also, that there can be no perpetual *Motion* in any Engine from one single Impulse; for this *Motion*, that it may return again upon the first Mover, must be propagated in an Orbit; and consequently must by Degrees cease and stop.

PER *Quæ Servitia*, in Law, is a Writ Judicial issuing from the Note of a Fine, and lieth for Cognisee of a Mannor, Seigniory, Chief Rent or other Services; to compel him that is a Tenant of the Land at the Time of the Note of the Fine levied, to attorn unto him.

PERPENDICULAR, in Geometry; when a Right Line standeth so upon another, that the Angles on either side are equal; then this Right Line which so standeth erected, is *Perpendicular* to that upon which it standeth.



Thus: The Line *AB* is *Perpendicular* to the Line *CD*, when the Angles on either side are equal: That is, If the Angle  $ABC =$  to the Angle  $ABD$ , and either of these Angles is equal to a Right one.

A Right Line is said to be

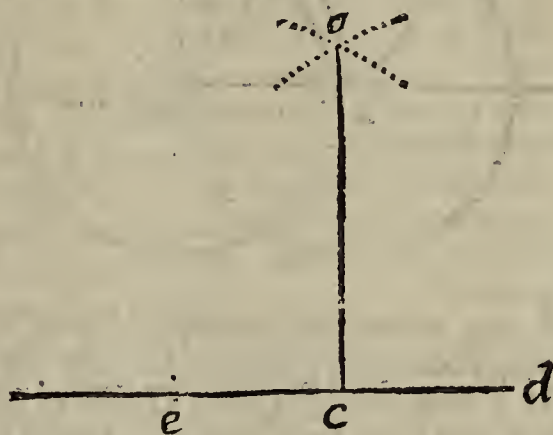
PERPENDICULAR to a Plane, when 'tis Perpendicular to all the Lines it meeteth with in that Plane.

One Plane is

PERPENDICULAR to another, when a Line in one Plane is Perpendicular to the other Plane.

### PROBLEM I.

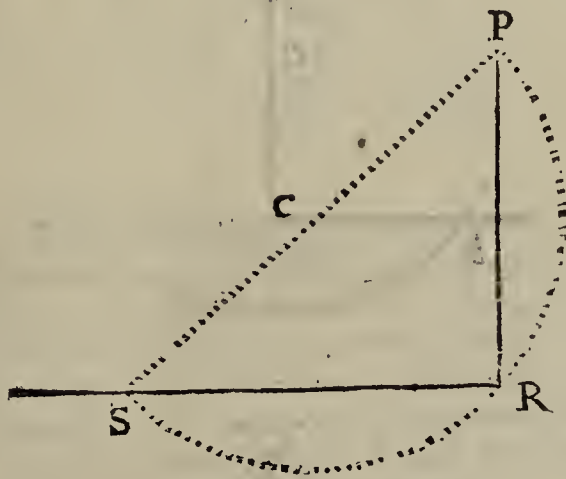
To Erect a Perpendicular on any assigned Point of a given Right Line. As suppose on the Point *c*:



On each side of the given Point *c*, cut off  $ce = cd$ ; and with the Distance  $de$ , (or any other greater than  $dc$ ) describe two Arches from *d* and *e*, intersecting each other in *a*, join *ac*; which shall be the *Perpendicular* required.  $\square$  *Euclid.*

### PROBLEM II.

To Erect a Perpendicular, on, or near the End of a given Line. As suppose at *R*.



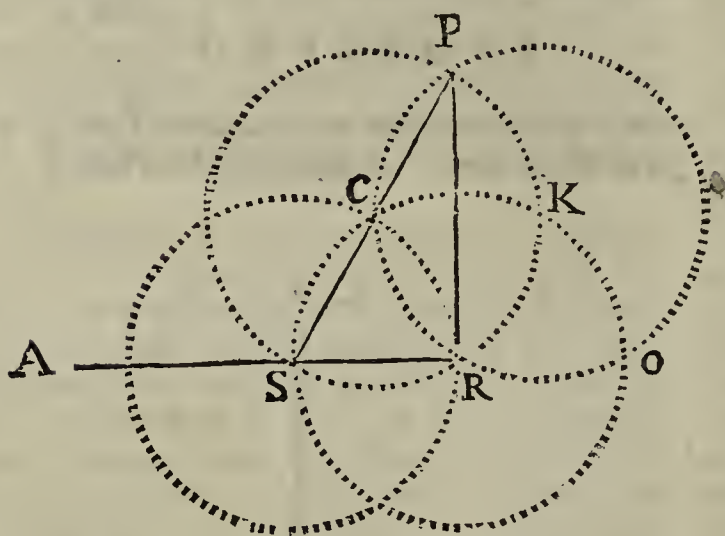
Open your Compasses to any convenient distance, and setting one Foot in *C*, draw the Circle *PRS*. Lay a Ruler from *S* thro' *C*, it will find the Point *P* in the Circumference; from whence draw *PR*, and 'tis done.

For the Angle *PRS*, being in a Semi-circle, must be a Right one; (by 31  $\hat{e}$  3 *Eucl.*) and consequently *PR* must be *Perpendicular* to *SR*.

The same may be otherwise performed thus:



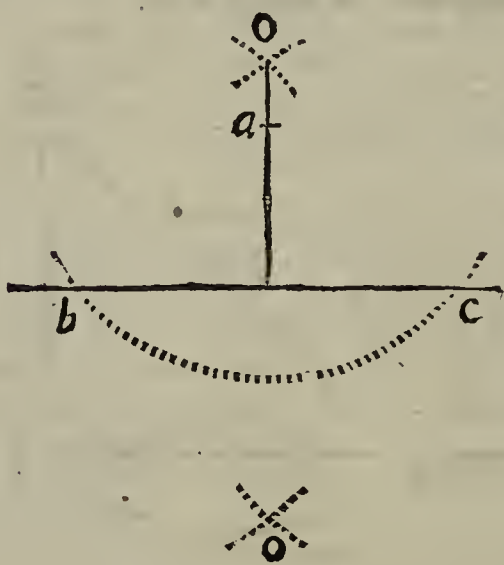
Suppose on A R, the Perpendicular P R were to be erected at the End R.



With any convenient opening of your Compasses, one Foot being placed in R, draw the Circle OCS; then with the same Distance, set one Foot in S, and cross the Circle in C, as also in K; then on the Centres C and K, draw (with the same Distance) two more Circles cutting each other in P; I say P R, will be Perpendicular to A R. For the Angle P R S is a Right one, being in the Semi-circle P K R S.

### PROBLEM III.

To let fall a Perpendicular on a given Line, from a given Point. As a.



Set one Foot of the Compasses in a the Point given, and with the other cross the given Line in the Points b and c: Then setting the Compasses in b and c, draw two Arks, crossing each other below in o: Then lay a Ruler from a to o, and 'tis done.

The Demonstration depends on the 9th of Euclid.

PERPENDICULAR, or *Right Plane*, is where a *Plane*, (like a well-made Wall) inclines and leans on one side, no more than it doth on the other.

PERPENDICULAR to a *Parabola*, is a Right Line cutting the *Parabola* in the Point in which any other Right Line touches it, and which is also it self Perpendicular to that Tangent.

PERPENDICULARITY of *Plants*, [in *Botany*] a curious Phenomenon observ'd by Mr. *Dodart*, which is as follows: 'Tho' almost all Plants rise a little crooked, yet the Stems shoot up perpendicularly, and the Roots sink down *perpendicularly*: Nay, even such as are diverted out of the Perpendicular by any violent Means, and do by Reason of the Declivity of the Soil come out inclined; they again straighten themselves, and recover their Perpendicularity by making a second or contrary Bend or Elbow, without rectifying the first.

PERPETUAL *Causick*. See *Infernal Stone*.

PERPETUAL *Glandules* [in *Anatomy*] are those Glands which are natural; and are thus distinguished from adventitious ones.

PERPETUITY, a Term used in Law, where an Estate is so designed to be settled in Tail, &c. that it cannot be undone or made void.

PERPETUITY [in the *Canon Law*] the Quality of a Benefice that is irrevocable, or that the incumbent cannot be deprived, except in certain Cases determined by Law.

PERQUISITE, is any Thing gotten by a Man's own Industry, or purchased with his own Money, different from that which descends to him from his Father or Ancestors.

PERQUISITES of *Court*, in Law, signifie those Profits that grow to a Lord of a Mannor, by vertue of his *Court Baron*, over and above the certain yearly Profits of his Land, as Fines of Copyholds, Hariots, Amerciaments, Waifs, Strays, &c.

PERRON [in *Architecture*] a Stair-Case that lies open on the Outside of a Building; properly the Steps in the Front of a Building, which lead into the first Story when raised a little above the Level of the Ground.

PERSIAN *Order*, *Perfick* [in *Architecture*] a Name apply'd to all Statues of Men, that serve instead of Columns to support Entablatures; they differ from the *Caryatides*, in that the last are only Statues of Women.

PER. SE, a Term of Art often used; as in Logick, we say a Thing is considered *Per se*, when 'tis taken in the Abstract, and without Connexion with other things, which would confound the Notion, and hinder its being clear.

In Chymistry, a Thing is said to be Distilled *Per se*, when 'tis without the usual Additaments of other things with it.

We say also a Man performs any Action, or Executes any Office *per se*, when he doth it *himself in Person*, and not by a *Deputy* or *Substitute*.

PERSEUS, a Constellation in the Northern Hemisphere, consisting of 38 Stars.

PERSONABLE, in Law, signifies as much as enabled to maintain Plea in a Court, thus: The Defendant was adjudged Personable to maintain his Action. Also the Tenant pleaded, that the Wife was an Alien Born in *Portugal*, without the Allegiance of the King; and Judgment was demanded, Whether he should be answered: The Plaintiff saith, She was made *Personable* by Parliament; that is, as the *Civilians* would speak it, *Habere personam standi in judicio*. *Personable* is also as much as to be of Capacity to take any thing granted or given.

PERSONAL *Verb*, in *Grammar*, is one that is Declined or conjugated with all the Three Persons, and in both Numbers; whereas an *Impersonal*



*personal Verb* is only used in the Third Person Singular.

PERSONAL Services. See Services.

PERSONAL, in Law, when 'tis join'd with the Substances, Things, Goods or Chattels; as Things *Personal*, Goods *Personal*, Chattels *Personal*, signifie any moveable Thing belonging to a Man, be it quick or dead: Thus, they say, Theft is an unlawful Felonious Taking away another Man's moveable *Personal* Goods.

PERSONAL Tythes, are Tythes paid of such Profits as come by the Labour of a Man's Person, as by Buying and Selling, Gains of Merchandize and Handicrafts, &c. See Tythes.

PERSONALITY, is an Abstract of *Personal*: the Action is in the *Personality*, viz. It is brought against the right Person, or the Person against whom in Law it lies.

PERSONS *ne Prebendaries ne seront chargées as quinsim*, &c. is a Writ that lies for *Prebendaries*, or other Spiritual Persons, being distrained by the Sheriff or Collectors of Fifteens, for the Fifteenths of their Goods, or to be contributory to Taxes.

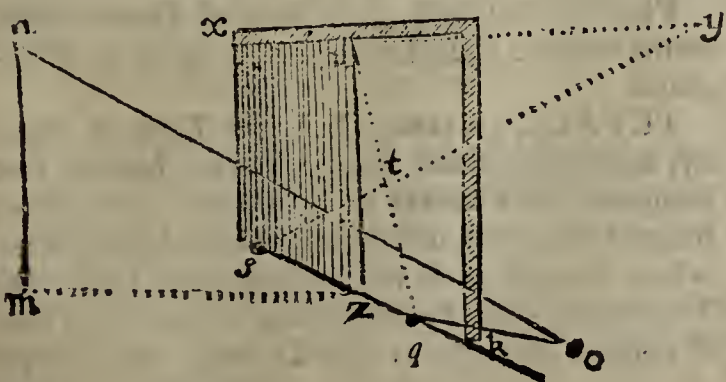
PERSPECTIVE, is that Part of the Mathematicks which gives Rules for the representing of Objects on a plain Superficies, after the same Manner as they would appear to our Sight, if seen thro' that Plain, it being supposed as transparent as Glass.

*Perspective* is either *Speculative* or *Practical*.

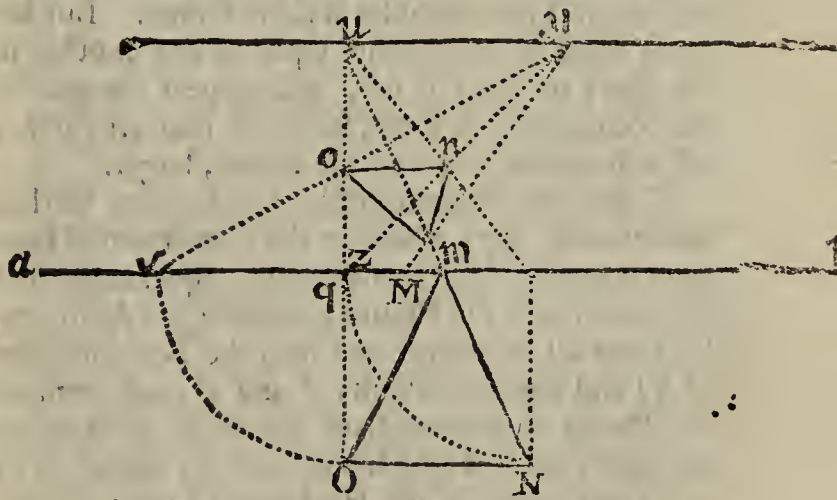
*Speculative Perspective*, is the Knowledge of the Reasons of the different Appearance of certain Objects, according to the several Positions of the Eye that beholds them.

*Practical Perspective*, is the Method of Delineating that which is apparent to our Eyes or that which our Understanding conceives in the Forms that we see Objects.

PERSPECTIVE: The Foundation or Ground of *Perspective*, may be thus conceived. Suppose there be a Point as *o*, which is seen by the Eye at *n* (whose Height above the Horizon is *nm*) thro' the *Glass* or transparent *Plane* *xzk*, which in *Perspective* is called the *Table*: And it be required to find the true Representation of this Point in *Perspective*; from *m* the Point of the Horizon perpendicularly under the Eye at *n* draw at Right Angles to *nm* (the height of the Eye) the Line *mz*; at *z* in the *Table* erect the *Perpendicular* *zu* equal to *nm*, and at Right Angles to it; from the Point *u*, draw also *uy* equal to *mz* the Distance of the Eye from the *Table*. From *o* let fall a Perpendicular to the Base of the *Table*, as *oq*, and draw the Line *qu*. Take *qs = to qo*, draw *sy* cutting *uq* in the Point *t*, so is *t* the point required.



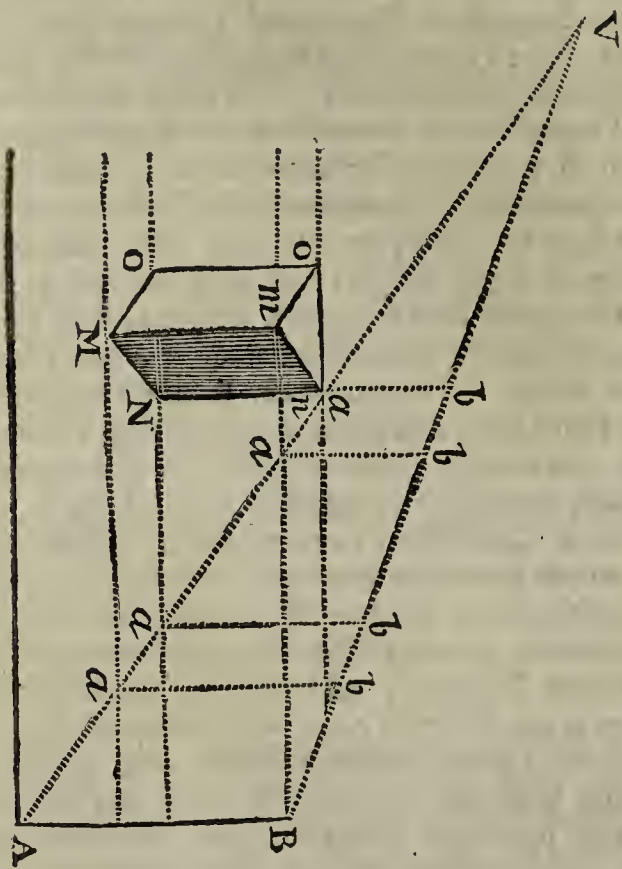
On this Foundation is the primary Rule of all *Perspective* built, and all its Practices established, v. gr. Suppose an Equilateral Triangle (as *mno*) or any other Geometrical Plane Figure were to be represented in *Perspective*. Between the Eye and the Triangle draw somewhere the Right-line *ab*, which they call the *Fundamental Line*; then draw *zv* representing the perpendicular Distance of the Eye above that Line, be it what it will, and thro' *v* draw, at Right Angles to *zu*, or parallel to *ab*, the *Horizontal Line* *vy*; then will the Plane lying between those Parallels represent the *Table* or *Transparent Plane*. Then in order to find the perspective Point for *o*, one of the Angles of the Triangle *omn*, draw *oq* perpendicular to the *Fundamental Line* *ab*, and make *qs* equal to *qo*. Take *uy* equal to *uz*, and then from *y* draw *sy*; draw also *vq*, whose Intersection with *qs* will find the point *o*, which will be the true Representation of *o* in *Perspective*; proceed after the same manner with the Points *M* and *N*, and drawing the Lines *on*, *nm*, *mo*, the Triangle *onm* will be the true Representation of the Triangle *MNO*. And thus proceeding with the Angular Points of any Figure, whether regular or irregular, you may draw any thing truly in *Perspective*; only in Practice, several compendious Methods will arise, which every one will discover on frequent Tryals.



And if the Scenographick Appearance of any Solid were to be represented, as suppose of a Triangular Prism whose Base is the Triangle *MNO* in the second Figure; you need only find the upper Surface of it after the same way as you found the lower or the Base, and then joining the corresponding Points by Right-Lines you will have the true Representation of the Solid in *Perspective*. So that the Work is the same as before, only you take a new *Fundamental Line*, as much higher than the former, as is the Altitude of that Solid whose Scenographick Representation you would delineate.

But there is yet a more commodious Way of doing this, as follows; Having found, as above, the Base, or *Ichnographick Plane* *mno*;





Let Perpendiculars be erected to the *Fundamental Line*, from the three angular points, which will express the Altitudes of those Points. But because these Altitudes, tho' equal to one another in the Body or Solid it self, will appear unequal in the Scenographick View, for those that are further off will appear less, and the nearer, larger.

Their true proportionable Heights may be thus determined: Any where in the *Fundamental Line* let *AB* be erected perpendicularly, equal to the true Altitude (or if the Figure hath different Altitudes, let them all be transferred into the Perpendicular *AB*) and from the Points *A* and *B* (and from all the Points of intermediate Altitudes (if there be any such) draw Right Lines to the Eye point in *V*, or to any point in the Horizontal Line: Those Lines *AV* and *BV* will constitute a Triangle with *AB*, within which all the Points of Altitude will be contained. Thro' the Points *o*, *n*, and *m*, draw parallels to the *Fundamental Line*, as you see, and from the points *a*, *a*, *a*, erect Perpendiculars to those Parallels, and where they intersect the two Lines *AV* and *BV*; as in the points *a*, *a*, *a*, and *b*, *b*, *b*, &c. they will determine the apparent Height of the Solid in that Scenographick Position to the Eye at *V*. And in practice these Parallels and Perpendiculars are to be easily described by the Help of a good *Drawing-Board* or *Table* fitted for this purpose, and others of this Nature.

Authors on this Subject of *Perspective*, are,

- Alberti Dureri Perspectiva, cum Fig.*  
*Hansen Leucours Perspectiva, in High-Dutch.*  
*Ulm. 1617. Fol.*  
*Henrick Loutensack Perspectiva, ditto. Frank.*  
*1618.*  
*La Perspective curieuse de Nicéron. a Paris.*  
*1663.*  
*La Perspective avec la Raison des Umbres, &c. par*  
*Solamon de Causa.*  
*Roger Bacon's Perspective. Lat.*

*Joan. Cantuariensis Archiepiscopi Perspectiva communis.*

*Loinganno de Glocchi Perspectiva practica.*

*Leada Regele delle Perspectiva.*

*Verdmanni Frisii Perspectiva.*

*The Jesuits Perspective: or, La Perspective pratique par un Religieux, &c.*

*Moxon's Practical Perspective.*

*G. Ubaldi Perspectivæ Lib. 6.*

*La Perspective speculative & pratique, par Mignon.*

*Lamii Perspective.*

*Andreae Alberti de Perspectiva & Umbra, Lil.*

**PERSPECTIVE** is also used for a kind of Picture or Painting, such as at the Ends of Galleries and in Gardens design'd to deceive the Sight by representing the continuation of an Alley, a Landskip, a Building or the like.

**PERSPECTIVE Plane** is a Glass or other transparent Surface, supposed to be placed between the Eye and the Object, perpendicular to the Horizon, except the contrary be mentioned expressly.

**PERSPECTIVE Lineal**, is the Diminution of those Lines in the Plan of a Picture, which are the Representation of other Lines very remote.

**PERSPECTIVE Aereal**, is a proportional Diminution of the Tints and Colours of a Picture, when the Objects are supposed to be very remote.

**PERSPECTIVE Military**, is when the Eye is supposed to be infinitely remote from the Table or Plane.

**PERSPICUOUS**, is that which is clear and transparent, as that the Light may be seen freely thro' it. See *Diaphanous*.

**PERSPIRATION**, a breathing through, as Sweat through the Invisible Pores of the Body.

**PERTICA**, a Sort of Comet, the same with *Veru*.

**PESA**, *Pensa*, *Pisa*; is a *Wey* or *Weigh*, or a certain Weight or Measure of Cheese and Wooll, containing formerly 256 Pounds.

**PESAGE**, is a Duty paid for weighing of Merchandize and other Wares, to a certain common Weigher, whom they called *Pesarius*.

**PESSARY**, is an Oblong Medicine, which being made of the Length of the Middle-Finger, is thrust up into the Neck of the Womb, and is good against several Diseases incident to it.

**PESSULUS**, the same with *Pessary*.

**PESSUS**, the same.

**PESTILENTIAL Fever**, is that which does not only afflict the Patient with a bare Distemper or Heat arising from Putrefaction, &c. but also with a Malignant and Venomous Quality. It differs from the Plague, as a Species or Sort from the Genus or Kind; because a Pestilence may sometimes happen without a *Fever*. *Blanchard*.

**PESTOLOIDES**, is a Sort of Urine which seems to have little Leaves or Scales in it. *Blanchard*.

**PETALA**, [*πίταλον*, Gr.] is a Term in Botany, signifying those fine coloured Leaves that compose the Flowers of all Plants. And from hence Plants are distinguished into *Monopetalous*, whose Flower is all in one continued Leaf; and *Tripetalous*, and *Pentapetalous*, when the Flower consists of three or five Leaves; and *Polypetalous*.



*alous* when of many, without determining the Number.

PETARD, in Fortification is an Engine of Metal in the Form of an High-crown'd Hat, with narrow Brims, which being filled with very fine Powder, well primed, and then fix'd with a *Madrrier* or Plank, bound fast down, with Ropes running through Handles, which are round the Rim of the Mouth of it, to break down Gates, Port-cullices, Draw-bridges, Barriers, &c. This Engine is from 7 to 8 Inches deep, and 5 broad at the Mouth; the Diameter at the Bottom or Breech is an Inch and a half, and the Weight of the whole Mass of Metal is from 55 to 60 Pounds, generally requiring about 5 Pounds of Powder for the Charge. They are also used in Countermines to break through into the Enemies Galleries, and to disappoint their Mines.

PETECHIALIS, is a Malignant Fever, called also *Pulicaris*, because it makes the Skin look as tho' it were Flea-bitten.

PETER-Pence, called also *Hearth-pence*, *Rome Scot*, and in the North *Ream-Pence*; was a Levy of a Penny on every House wherein there were 30 Pence *vivæ pecuniæ*, to be collected and sent to *Rome*: This at first tho' only a Contribution, at last pass'd into a standing Tax; one half of it went for Alms to the *English School at Rome*, and the other half to the Pope's Use.

It was at first given by King *Ina*, and confirm'd by *Offa* and *Ethelwolp*; established by the Laws of *Canute*, *Edward the Confessor*, *William the Conqueror*, and *Henry I.* 'Twas collected by the Bishops, who employed the Rural Deans and Archdeacons to receive it. The whole Sum was by Pope *Gregory* stated at 200 *l. 2 s. 6 d.* In the Year 1365, King *Edward* the Third first forbade the Payment of this Duty to the Pope; but the Custom soon returned again, and continued till the Reign of *Henry* the Eighth, when *Polydore Vergil* was employed here as the Pope's Receiver-General. No Place nor Religious House was exempt from this Imposition, but only the Abby of *St. Albans*.

PETIGO. See *Lichen*.

PETIT Cape. See *Cape*.

PETIT Larceny. See *Larceny*.

PETIT Treason. See *Petty*.

PETIT-Sergeanty: To hold Lands or Tenements in *Petit-Sergeanty*, is to hold them of the Crown, by yielding the Sovereign a Knife, Buckler, Arrow, or a Bow without a String, or other like Service at the Will of the first Feoffer; and there belongs neither Ward, Marriage nor Relief: No one can hold Land in Grand or Petit-Sergeanty, but of the Crown. See *Stat. of Car. 2. c. 24.*

PETITIO Principii, *Begging of Principle*, is a precarious supposing a Thing to be true, or taking it for granted, when it really remains either dubious, or else is expressly denied. This frequently is called *Begging the Question*, when a Man supposes what he should prove.

PETREFACTION, is properly the changing of a mix'd Body into a Stony Substance, when it had no such Nature before; and the Action by which this is performed, is called

PETREFICATION, and the Thing so chang'd is said to be *Petrefied*. 'Tis justly questionable, Whether there be any such Thing as *this* in Na-

ture, or not. *Petrefaction* indeed now-a-days is a mighty modish Word, for every Thing almost that is found upon the Surface, or dug out of the Earth, passes with some Persons by this Name. But what is there that really and truly deserves the Name of *Petrefaction*? When the *Petrefying Waters*, as they are called, (which are nothing but Waters impregnated with a great deal of Stony Matter, which in their Passage through the Earth became dissolved in them:) When these, I say, incrustate Rushes, Grass, or Sticks, all over with a Stony Coat, by letting the Stony Particles dissolved in them by little and little fall down upon and adhere to them; or, it may be, insinuate into their Pores, and deposite themselves there. And when after this the Vegetable Part inclosed rots and moulders away, and the Stony Coat or Substance daily increases; this is not the Transmutation of a Vegetable Substance into a Stony or Mineral one; and therefore the new Body thus formed, is not properly a *Petrefaction* in the true Sense of the Word.

And when many Bodies are found in the Earth, which by all possible ways of judging and distinguishing, approve themselves to be Animal or Vegetable Bodies, such as the Shells, Teeth, Bones, of Animals, the Fossil-Trees, Pine-Cones, Hazel-Nuts, &c. which are every where found deep in the Earth. It appears odd to call these *Petrefactions*, and more odd to suppose them nothing but the *Sportings of Nature*; and to affirm all these Things to be nothing but meer *Formed Stones*, only because we cannot account presently how they came thus into the Earth, or solve all the Objections or Difficulties about them. But every one will have his own way of Expression.

PETROSUM Os, is the Internal Process of the Bones of the Temples, so called from its Hardness and Cragginess: 'Tis pretty long, jetting out to the Inner Basis of the Skull, within which it hath two Holes, and thro' one of them an Artery, and thro' the other the Auditory Nerve passes to the Inner Cavities of the Ear, that are excavated in this Process, viz. the *Tympanum*, *Labyrinthus*, and *Cochlea*; and without the Skull it hath three Holes: The first of which is the *Meatus Auditorius*: The second is narrow, short, and oblique, near to the first, and thro' it the Jugular Vein enters the Inner Cavities: The third is seated betwixt the *Processus Mammillaris*, and the *Styloides Appendix*, and ends in the Passage which goes from the Ear to the Mouth.

PETTERERO. See *Pedrero*.

PETTY Tally [in Sea Language] is a competent Allowance of Victuals according to the Number of the Ship's Company.

PETTY Treason [in Law] is the Crime of a Servants killing his Master; a Wife's killing her Husband; a Child's killing his Parents; and a Clergyman's killing his Prelate to whom he owes Obedience; the Punishment of which in Woman is the same as that of High-Treason, i. e. *burning*, and in Man being drawn on a Sledge or Hurdle to the Gallows and there hanged.

PEVETS, are the Ends of the Spindle of any Wheel in a Watch; and the Holes into which they run, are called *Pevet-Holes*.

PEYNE fort & dure. See *Payne fort & dure*.

PHACIA. *Vid. Lenticula*.



PHACOS, [φακός, Gr.] is a Spot in the Face like a Nit, whence it is called *Lenticula* and *Lentigo*.

PHÆNOMENON [φαινόμενον of φαίνω, Gr. to appear] is in Physicks an extraordinary Appearance in the Heavens or on Earth; discovered by the Observation of the Celestial Bodies, or by Physical Experiments, the Cause of which is not obvious.

PHAGADÆNA, [φαγάδαινα, Gr.] is an exulcerate Cancer.

PHAGADENICK Water, is made by dissolving a Dram of Sublimate Corrosive in a Pound of Lime-Water, on which it will immediately turn Yellow.

PHALACROSIS, [φαλάκρωσις, Gr.] is the falling off of the Hair.

PHALANGOSIS, [φαλάγγωσις, Gr.] is a Fault of the Eye-lids, when there are two Rows of Hair, or when the Hair grows inward and offends the Eyes.

PHALANX, according to some Writers, is the Order and Rank observed in the Finger-Bones.

PHALANX, among the *Macedonians*, was an oblong square close Battle of Pikemen, consisting of 16 Files, and 500 in Front, as *Polybius* saith; and the Soldiers stood so close together, that the Pikes of the 5th Rank extended 3 Foot beyond the Front of the Battle.

PHANTASY, [φαντασία, Gr.] is an Internal Sense or Imagination, whereby any Corporeal Thing is represented to the Mind, or impressed on the Brain by its proper Image.

PHANTASTICAL Colours, are such as are exhibited by the Rain-bow, Triangular Glass Prism, the Surface of very thin *Muscovy* Glass, &c. They had this Name given them by the *Peripatetick Philosophers*, who supposed them to be no real Colours. This *Kircher* well refutes in his *Mundus Subterraneus*, Part 2. p. 15, 16. and shews also the Cause of such Colours.

PHARMACEUTIC, [of φάρμακον and χέω, Gr. to prepare] the same with *Pharmacum*.

PHARMACOPŒA, [of φάρμακον and ποίω, Gr. to make] is the Doctrine or a Description of Things Medicinal, in order to cure Diseases.

PHARMACUM, [φάρμακον, Gr.] is any Sort of Medicine against a Disease.

PHARMACY, is an Art of Collecting, chusing, and compounding Medicines, viz. the Apothecary's Art; to which may also be added the Chymical Analysis of Bodies, in order to prepare good Medicines out of them.

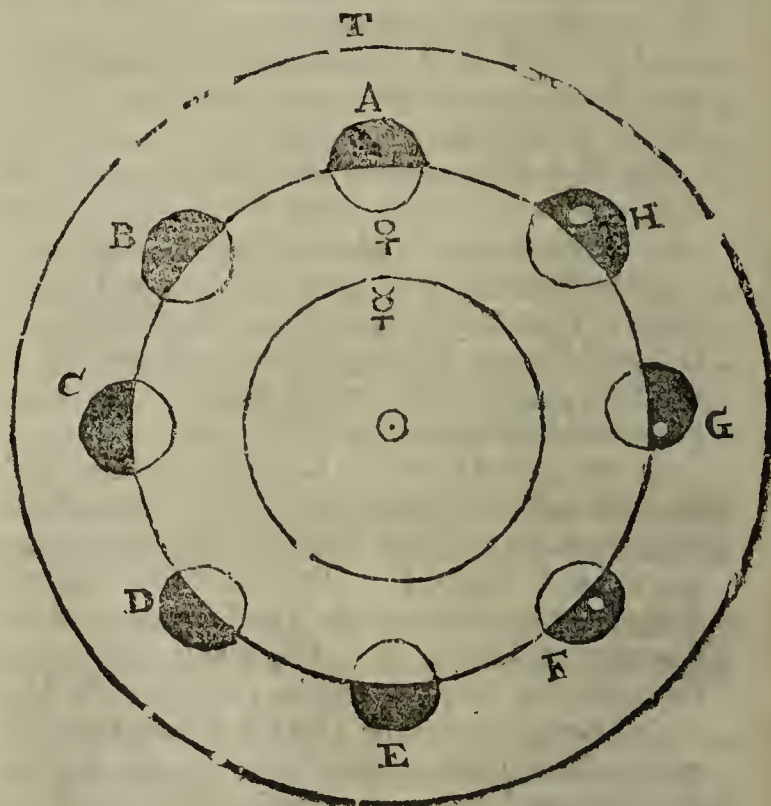
PHARYNGETRUM is sometimes used for the *Pharynx*, sometimes for the Bone *Hyades*.

PHARYNX, [φάρυγξ, Gr.] is the upper Part of the Gullet, consisting of three Pair of Muscles; to which some add another, making the Number seven: It is continued to the *Fauces*, (or indeed is the greatest Part thereof) reaching up behind to the *Uvula*, on the Sides to the *Tonsillæ*, and before to the *Epiglottis*: It is *Membranous*, but not entirely so, being in some Places Carnous and Thick. Three Pair of its Muscles open it in the Action of swallowing; and the odd one is a *Sphincter* which serves to straiten it.

PHASIS, signifies the Appearance or the Manner of Things shewing themselves, and therefore in Astronomy is used for the several Positions in

which the Planets, (especially the Moon) appear to our Sight; as obscure, horned, half illuminated, or full of Light, which by the help of a *Telescope* may likewise be observed in *Venus* and *Mars*.

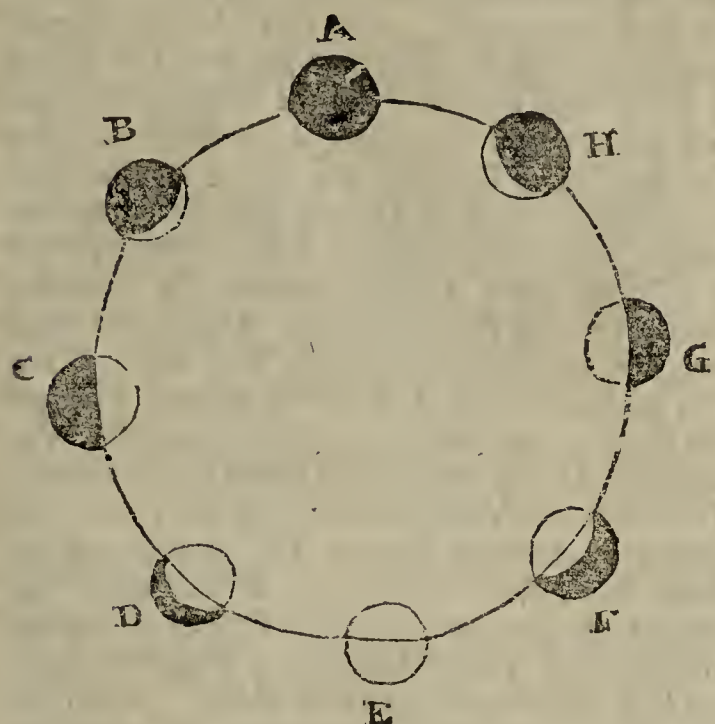
PHASES of the Planets: Since all the Planets as well as the Earth are spherical, opaque, and scabrous Bodies, they must reflect every way the Sun's Rays which fall upon them; and it will follow also from hence, that one half of every Planet, or that Hemisphere which is turned towards the Sun, will be illuminated by him, and the other Hemisphere at that Time must remain in Darkness. And further, since 'tis that Hemisphere of any Planet, which is obverted to the Earth, which is considered by any Observer:



The eight little Circles represent the different Phases of *Venus*, as they will appear to an Eye placed in T on the Earth, while she moves round in her Orbit A C E G about the Sun. It will be plain then, that when *Venus* is in A, and the Earth at T; she being then most retrograde, (see the Word *Direct*) will least of all appear to us, because her obscure Hemisphere is entirely obverted towards us. And if she happen to be then in either of the Nodes, i. e. in the Plane of the Ecliptick, she will appear like a Spot in the Body of the Sun.

But when she gets further to B (the Eye being still supposed to be in T) she will still be retrograde, but some small part of her illuminated Disk will be visible; and she will appear with illuminated Horns which will be turned from the Sun, or towards the West. When she comes to C, one half of her illuminated Disk will be visible to an Eye in T, and then she will appear like an Half-Moon; in D she will be gibbous, and in E at full. And the same Phases she will put on as she moves in the other Semicircle from E to A again, only the illuminated Horns will be turned a contrary Way; as appears by the second Figure, where all the several Phases are delineated.





And the same kind of Phases must happen to *Mercury* in the several parts of the Orbit, Regard being had to the Figure of it, and the Time of his Periodical Revolution round the Sun.



**PHEONS**, in Heraldry are the Barbed Heads of Darts or Arrows, and are usually of this Figure.

*Sable, a Fesse Ermine between three Phæons, by the Name of Egerton.*

**PHILANTHROPY**, [*φιλανθρωπία* of *φίλος*, a *Lover*, and *ἄνθρωπος*, Gr. a *Man*] is a generous Love for Mankind in general, or an Inclination to promote the publick Good.

**PHILONIUM**, [so called of *Philo* its Author] is an Opiate Medicine; of which they reckon two Sorts, the *Philonium Romanum* and *Perficum*.

**PHILOSOPHICAL Egg**, among the Chymists is a thin Glass Vessel, or Bubble, of the Shape of an Egg, with a long Neck or Stem: 'Tis used in long Digestions.

**FILTRATION**. See *Filtration*.

**PHILTRUM**, [*φίλτρον*, Gr.] is the Hollow dividing the Upper Lip.

**PHIMOSIS**, [*φίμωσις*, Gr.] is the same with *Paraphimosis*; also the Inversion of the Eye-lids through an Inflammation.

**PHLEBORAGIA**, [of *φλέψ* a *Vein*, and *ῥήγνυμι*, Gr. to break] is the breaking of a Vein.

**PHLEBOTOMY**, [*φλεβοτομία* of *φλέψ* a *Vein*, and *τέμνω*, Gr. to cut] opening of a Vein, or letting of Blood.

**PHLEGM**, [*φλέγμα*, Gr.] or *Water*, the Fourth of the Five Chymical Principles. See *Water*.

The Insipid Water that comes first in the Distillation of Acid Spirits, the Chymists call the *Phlegm*: And the more any such Spirit is rectified, that is, distilled over again, to draw off still more of this *Phlegm*, they say 'tis the better *dephlegmated*.

**PHLEGM of Vitriol**, is the Moisture that is first drawn off when *Calcined Vitriol* is distilled, in

order to get its Spirit and Oil; it comes off with a gentle Heat.

**PHLEGMAGOGUES**, [*φλεγμαγόγα* of *φλέγμα* and *ἀγωγός*, Gr. a *Leader*] are Medicines which purge or drain away that Humour which they call *Phlegm*.

**PHLEGMON**, [*φλέγμαν*, Gr.] So the Surgeons call an hot Tumour, proceeding from an Over-affluxion of Blood to any part.

**PHLEGMONODES Febris**, [of *φλεγμονή* of *φλέγω*, Gr. to burn] a Fever with an Inflammation of the Blood.

**PHLOGOSIS**, [of *φλογόω*, Gr. to inflame] is a light Inflammation of the Eyes, with a small Pain and Redness; which sometimes turns into a true *Ophthalmia*, and is the Original thereof.

**PHLYCTÆNA**, [*φλύκταινα*, Gr.] is a Pimple in the Skin, also a little Ulcer, like a Bubble or Bladder, in the Corneous Tunick of the Eye, and proceeding from a sharp watry Humour. *Blanchard*.

**PHCENIGMA**, [*φαινιγμός*, Gr.] a Medicine which raises redness with Blisters on the part it is apply'd to.

**PHONICKS**, the same with *Acousticks*; which see.

**PHOSPHORUS**, [*Φωσφόρος* of *φῶς* Light, and *φέρω*, Gr. a bringer] a Name given by Astronomers to the Morning Star or the Planet *Venus*, when she goes before the Sun.

**PHOSPHORUS**, [*Φωσφόρος* of *φῶς* Light, and *φέρω*, Gr. to bear] a Chymical Preparation, which being exposed to the Light or Air, will shine in the Dark. Of this there are several Kinds whose Process shall be briefly delivered.

To make the *Bolonian Phosphorus*, see under the *Bolonian Stone*.

The most common Way (with us) is to make the *Phosphorus* from Humane Urine. And the Hint came first by Chance thus:

One *Brand* an Alchymist of *Hamburgh*, wisely thinking to find the Philosopher's Stone in Human Urine, work'd upon it in a Retort, and so forced over the *Phosphorous* Matter; yet he would not communicate this Discovery to any one, and so the Secret died with him. After his Death, one *Kirkbelius*, a *Saxon* Chymist set himself to find it out, (having heard of such a Thing,) and succeeded accordingly; and this Man shewed the Process to several of his Friends.

The Honourable Mr. *Boyle* having (in part) had an Account of this *Phosphorus*, from one *Daniel Kraff*, a *German*, about the Year 1680, published in *English* an Account of the Way of making this *Phosphorus*, and several very Curious Experiments upon it, under the Title of *Noctiluca*. And since that, Mr. *Homburg* hath written largely about it, as you may see in the Memoirs (for the Months *March* and *April*) of the Royal Academy of Sciences at *Paris*, 1692.

*The Way of Preparing it, is this:*

Take a good large Quantity of the New-made Urine of Beer-drinkers, and evaporate it gently, to the Consistence of Honey: Then put it in an Earthen Vessel, cover, and place it in a Cellar for three or four Months, that it may thoroughly ferment



ment and putrefie. Then mix a double Quantity of Sand, or Powder of Pots, with one part of this corrupted Urine, and put it into an Earthen Retort or Glass one Coated; and fitting it to a large long-neck'd Glass Receiver, in which was before put two or three Quarts of Water, distil it in a naked Fire, in a Reverberatory Furnace, gently at first, for about two Hours; afterwards augment the Fire gradually, 'till all the Volatile Salt and black Fœtid Oil be drawn off. Then raise the Fire to the highest Degree, and white Clouds will come into the Receiver, and fix it by little and little, on one side of it, in the Form of a yellowish Skin, and another part will precipitate to the Bottom in Powder. Keep the Fire thus violent for three Hours, 'till no more Fumes will come. Let all cool, and unlute the Vessels; and throwing more Water into the Receiver, shake all well about to loosen what will stick to the Sides; and then pour it all into a large Glass Vessel, where it will settle; the Volatile Salt will dissolve in the Water, but the *Phosphorus* and the Oil will sink to the Bottom. Pour off the Water, and gathering the remaining Matter together, put it into a little Glass Vessel, with a little fresh Water, and digest it in a Sand-heat, stirring the Matter about from Time to Time with a Wooden *Spatula*; the *Phosphorus* by this Means will separate from the Oil, and sink to the Bottom. Pour away the Oil, and make the *Phosphorus* up while hot, into little Sticks or Pieces, which must be kept in a Viol of Water close stopp'd.

This is the *Solid Phosphorus*, with which, if you write any Letters on Paper, or on a Wall, they will appear Luminous in the Dark, and continue so a good while. If you cut off a little Bit of it, and rub it strongly along a piece of Paper with a Knife, it will actually enkindle the Paper.

The *Liquid Phosphorous* is made by digesting in Horse-dung a little Bit, or some Scrapings of the Solid, for two Days, in Oil or Essence of Cloves, Oil of Turpentine, &c. For after it is dissolved in the Oil, it will impregnate it so, that as soon as ever you open the Bottle, the Matter will appear all in a Flame.

If you put a little of the *Solid Phosphorus* into a Viol, with a little Oil of Vitriol, that is very strong and well dephlegmated, and then add to it about half as much common Water as there was Oil of Vitriol, the Mixture will grow very hot, and smok; and if you carry the Viol into the Dark, you will see the *Phosphorus* enkindled, and sparkle in many Places of the Viol, like Meteors, or little falling Stars: And if a small Quantity of Oil of Turpentine be added, it will produce an actual Flame.

*Lemery* mentions a New-invented *Phosphorus* of Mr. *Homberg's* being made of one Part of Salt Armoniack, and two of Quick-lime slack'd by the Air; which are fluxed together in a Crucible, into a kind of Gray Glass, which when it is struck with a Hammer, appears presently of a light Fire.

*Phosphorus Balduini*, called the *Hermetick Phosphorus*, is thus made:

Heat red-hot about two Pounds of Chalk, let it cool, and powder it. Then take a Pint of *Aqua fortis*, and put into it a Spoonful of your pow-

dered Chalk; a great Ebullition will arise: Repeat this 'till the throwing in of the Powder makes no Ebullition at all. After this, let the Liquor settle, and decant it into an Earthen Pan placed in Sand, and evaporate all the Liquor, so there will remain a kind of Salt at the Bottom. Put this Salt into a Coppel, or a strong Earthen unglazed Pan; set it in a gentle Sand-heat, and the Matter will swell. Continue this gentle Fire 'till it be sunk down a little towards the Bottom; then cover the Pan or Coppel with a Lid that hath two or three Holes in it, and encrease the Fire gradually, 'till it be strong enough to melt the Matter; and when 'tis melted, a yellow Vapour will exhale through the Holes in the Cover. Then take the Vessel presently off the Fire, and putting on another Earthen Lid, which hath no Holes in it, set it by to cool. Round about the sides of the Pan you will find a Crust of yellow Matter; that is the *Phosphorus*. It must be kept in a Box well stopp'd, in a dark place. When 'tis design'd to be render'd Luminous, you must expose it, like the *Bolonian Stone*, to the Light, for a small Space; and then removed into the Dark, it will shine there. If it be left in the Dark, exposed to the Air for about Fifteen Days, it will shine all that while; but after that go out, and never be Luminous more.

Mr. *Boyle*, in his *Aereal Noctiluca*, p. 103. describes a *Phosphorus Balduini* much like this; and in *Phil. Transf.* N° 199, there is of his a yet more accurate Process for this Thing.

The Learned Dr. *Stare*, in *Phil. Transf.* N° 150, makes an Ingenious Comparison between *Lightning*, and the Flashes which in warm Weather he had often observed (by Night) to arise from some Pieces of the *Solid Phosphorus*, kept in long Glass Bottles of Water about  $\frac{3}{4}$  filled.

PHOSPHORUS; by Order of, and before the Royal Society at London, Mr. *Hawksbee* made several Experiments on the *Phosphorus*, about the Production and Propagation of Light in *vacuo*; and it plainly appeared from them, that the removing the common Air did very sensibly encrease its Light. And by the Experiments made by the same Person on the *Mercurial Phosphorus*, and mentioned in *Phil. Transf.* N. 303. it is also manifest, that tho' *Mercury* when strongly agitated in the common Air would exhibit in a darkned Room some Sparks of Light, yet that a very sensible and eminent Degree of it might be produced by shaking it in proper Glasses in *Vacuo*.

*Bernouli*, Professor of Mathematicks at *Groningen*, made an easy portable *Mercurial Phosphorus* after this Manner: In a clean neat Viol he included about five or six Ounces of well purified clean Quicksilver; and evacuating the Viol of Air by applying to it an Air-Pump, it would, when shook strongly in the Dark, appear all bright and luminous, so as that one might distinguish the Faces of the Spectators.

PHOTASCIOTERICA, [of  $\phi\omega\varsigma$ , *Light*, and  $\sigma\eta\lambda\alpha$ , Gr. a Shadow] the Art of Shadows and Dialling.

PHRENES. See *Diaphragma*.

PHRENESIS, the same with *Phrenitis*.

PHRENETICK Nerves, are those which are called also *Stomachick*, and spring from Dr. *Willis's* Eighth Pair, or from the common reckoned Six



Six Pair: Those descend between the Membranes of the *Mediastinum*, and send forth Branches into them.

**PHRENICK Vessels**, are the Veins and Arteries that run through the *Diaphragm*, *Mediastinum*, and *Pericardium*.

**PHRENITIS**, [*φρενίτις*, Gr.] or *Phrenzy*, is a Dotage with a continual Fever, often accompanied with Madness and Anger; proceeding from too much Heat in the Animal Spirits, not from the Inflammation of the Brain, as the Ancients thought. *Willis* thus defines it, namely an Inflammation of the whole Sensitive Soul and Animal Spirits.

**PHRICOIDES**, [*φριχοειδής*, Gr.] is a dreadful Fever, in which Men are apt to fancy terrible Things.

**PHTHARTICUM**, [*φθαρτικόν*, Gr.] is a corrupting Medicine.

**PHTHIRIASIS**, [*φθιρίασις*, Gr.] is the Loufy Disease; also a Scaly Scab on the Eye brows. *Blanchard*.

**PHTHISIS**, [*φθίσις*, Gr.] is a Consumption of the whole Body, rising from an Ulcer in the Lungs, accompanied with a slow continued Fever, ill scented Breath and a Cough. *Blanchard*.

**PHTHOE**, the same with *Phthisis*.

**PHYGETHLON**, [*φύγεθλον*, Gr.] is a Swelling proceeding from an Inflammation of the Glandules, wherein Nature expels something; as in the Plague, about the Groins. *Blanchard*.

**PHILOSOPHERS Tree**. See *Diana's Tree*.

**PHYMA**, [*φύμα*, Gr.] is a Swelling: There are five Sorts, *Verrucæ*, *Calli*, *Vari*, *Furunculi*, and *Hydroa*, or *Defudationes*; of which, see under those Words. Others reckon it a Tumour in the Glandules only, which quickly separates. *Blanchard*.

**PHYSEMA**, [*φύσημα*, Gr.] an Inflammation in any part of the Body, as a Tympany. *Blanchard*.

**PHYSICKS**, [*φυσικὴ*, Gr.] or Natural Philosophy, is the Speculative Knowledge of all Natural Bodies, (and Mr. *Lock* thinks, That God, Angels, Spirits, &c. which usually are accounted as the Subject of *Metaphysicks*, should come into this Science,) and of their proper Natures, Constitutions, Powers, and Operations. See *Physiology*.

**PHYSICKS**, or Natural Philosophy. The most eminent Books on this Subject which will give the Reader a true and useful Knowledge of Nature, are these,

Sir *Is. Newton's Principia Philosoph. Naturalis Mathematica*.

*Ejusdem Optica: sive de Lumine & Coloribus*.

*Borellus de Motionibus à Gravitate pendentibus*.

— *De vi percussioneis*.

*Wallis Mechanicks, sive Liber de Motu Tractatus Geometricus*.

*Hon. Fabri Dialogi Physici*. Lugd. Galliarum. 1669. 8vo.

Mr. *Boyle's Physical Pieces*.

*Keil's Introductio ad Veram Physicam*.

*Ditton's Laws of Nature and Motion*.

*Cheyne's Philosophical Principles of Natural Religion*.

All Dr. *Hook's Tracts* printed while he was living, and his *Opera Posthuma*.

*Philosoph. Transactions*.

And *Collections*.

*Acta Eruditorum Lipsiæ*.

*Collegium Experimentale sive Curiosum, in quo primaria hujus seculi Inventa & Experimenta Physico-Mathematica inveniuntur* 2 Vol. 4to.

*Essays of Natural Experiments made in the Academy del Cimento, English'd by Mr. Waller*, 1684. 4to.

*Ray's Wisdom of God in the Works of the Creation*, Last Edit. with 3 *Phys. Discourses*.

*Woodward's Natural History of the Earth*.

*Bobun, of Winds*.

*De Resistentia Solidorum*, by *Alex. Marchettus*, Florentiæ. 1665. 4to.

*Hypothesis Physico-Nova* G. G. *Leibnitz*. Lond. 1671. 12mo. See N. 74. of *Phil. Transf.*

*Horologium Oscillatorium* *Christoph. Hugonii*, Paris. Fol. 1673.

*Traité de la Percussion ou Choque de Corps per M. Mariotte à Paris* 1673. 12mo.

*Traité de Mouvements des Eaux & des autres Corps Fluides par Feu. par M. Mariotte*. Paris. 1686. 8vo.

*Pardies Local Motion*, Engl.

*Exegesis Physico-Math. de momentis Gravium*.

*Whiston's Theory of the Earth*.

*Galilæi Dialogi de Mechanica & Motu Locali*.

— *de Systemate Mundi*.

*Sinclari Ars nova & magna Gravitatis & Levitatis*.

*Dee de Præstantioribus quibusdam Naturæ Virtutibus*. 4to Lond. 1558.

*Miscellanea Curiosa Germanica*, in 8 Vol. 4to.

*Physico-Mathesis de Lumine, Coloribus, & de Iride*. per *Grimaldi*.

**PHYSIOGNOMICKS**, [*φυσιογνωμική*, Gr.] is a Term used by some Physicians and Naturalists for such Signs as are taken from the Countenance of Persons, to judge of their Dispositions and Tempers.

**PHYSIOLOGY**, [*φυσιολογία* of φύσις *Nature*, and λόγος, Gr. a *Discourse*] *Physicks*, or Natural Philosophy, is the Science of Natural Bodies, and their various *Affections*, *Motions*, and *Operations*. This is either

*General*, which relates to the Properties and Affections of Matter or Body in general. Or,

*Special and Particular*, which considers Matter as formed or distinguished into such and such Species, or determinate Combinations.

**PHYSIOLOGY**, is by some also accounted a Part of *Physick*, that teaches the Constitution of the Body so far as it is found, or in its Natural State; and endeavours to find Reasons for its Functions and Operations, by the Help of Anatomy and Natural Philosophy.

Mr. *Keil*, in his *Introductio ad Physicam*, reckons Four Classes or Sorts of Philosophers which have treated of *Physicks* or Natural Philosophy.

1. Those who delivered the Properties of Natural Bodies under Geometrical and Numeral Symbols; as the *Pythagoreans* and *Platonists*.

2. The *Peripateticks*, who explained the Natures of Things by Matter, Form, and Privation;



tion; by Elementary and Occult Qualities; by Sympathies, Antipathies, Faculties, and Attractions, &c. And these did not so much endeavour to find out the true Reasons and Causes of Things as to give them proper Names and Terms; so that their Physick is a kind of Metaphysicks.

3. The *Experimental Philosophers*, who by frequent and well-made Trials and Experiments, as by Chymistry, &c. fought into the Natures and Causes of Things: And to these almost all our Discoveries and Improvements are due; and much more would they have done, if they had not fallen into *Theories* and *Hypotheses*, which they forced oftentimes their Experiments to maintain, whether they could or not.

4. The *Mechanical Philosophers*, who explicate all the *Phænomena* of Nature by *Matter* and *Motion*, by the Texture of Bodies, and the Figure of their parts; by *Effluvia*, and other subtle Particles, &c. And in short, would account for all Effects and *Phænomena* by the known and established Laws of *Motion* and *Mechanicks*: And these are, in Conjunction with the last named, *The Only True Philosophers*.

PHYTOLOGY, [*φυτολογία* of *φυτόν*, a Plant, and *λόγος*, Gr.] a Discourse or Treatise of *Plants*, or a Description of their Forms, Kinds, Properties, &c.

PIA *Mater*. See *Mater tenuis*.

PIAZZA's, or as our Vulgar frequently call them *Piaches*, are in the *Italian* the same as our Cloysters.

PICA. See *Citta*.

PICAGE, from the Latin *Pica* was a Custom or Duty paid at Fairs or Markets for breaking the Ground and pitching up of Stalls and Standings; and this Profit of Picage was usually given or granted in Charters for holding a Fair or Market.

PICATIO. See *Dropacismus*.

PICKET, in Fortification, is sometimes used for a Stake, sharp at one End, to mark out the Ground and Angles of a Fortification, when the Engineer is laying down the *Plan* of it; these are usually pointed with Iron. There are also larger *Pickets* which are drove into the Earth, to hold together *Fascines* or Faggots, in any Work cast up in haste. And *Pickets* also are Stakes drove into the Ground by the Tents of the Horse in a Camp, to tie their Horses to. And *Pickets* are also drove into the Ground before the Tents of the Foot, where they rest their Muskets or Pikes round about them in a Ring. When an Horseman hath committed some considerable Offence, he is often sentenced to *stand on the Picket*; which is, to have one Hand drawn up as high as it can be stretch'd, and then he is to stand on the Point of a *Picket* or Stake only with the Toe of his opposite Foot, so that he can neither stand or hang well, nor ease himself by changing Feet.

PIEDOUCHE, in Architecture, is a little Square Base smoothed, and wrought with Mouldings, which serves to support a *Bust* or Statue drawn half way, or any small Figure in Relief.

PICRA. See *Hiera picra*.

PIEDROIT, in Architecture, is a Square Pillar which is partly within the Wall. *Build. Dict.*

PIED-DROIT, in Architecture, is a Square Pillar, differing from a *Pillaster* in this respect, that it hath no Base nor Capital: It is taken also for Part of the *Jaumbs* of a Door or Window.

PIE-Powder-Court, is a Court held in Fairs, to yield Justice to Buyers and Sellers, and for Redress of all Disorders committed in them.

PIERCED, [in *Heraldry*] is when an Ordinary is perforated, or struck through, shewing as it were an Hole in it; the Shape of the piercing must be expressed in Blazoning, as, if the Hole be square, it must be blazoned square pierced; or if the Hole be round it must be expressed round pierced, the same as perforated.

PIESTRUM, [*πῆστρον*, Gr.] an Instrument used to beat in pieces the Bones of the Head in drawing a Child out of the Womb.

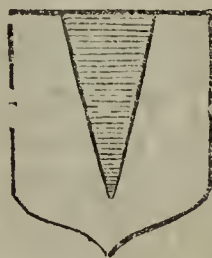
PIGER *Henricus* [with *Chymists*] i. e. Slow Henry, a slow distilling Furnace, called also *Athamor*.

PIGMENTS, are such prepared Materials as Painters, Dyers, &c. make use of, to impart to Bodies, or to imitate particular Colours. When Glass is stained or coloured, as in Painting on Glass, or for the counterfeiting of Gems or Precious Stones, the *Pigment* is usually of a Metalline or a Mineral Nature.

PILÆ, in Architecture, and their *Quadra's* and Tables (as we yet see them in ancient Altars and Monuments) were imploy'd for Inscriptions; but if shorter and more massy, they serve for Arches of Bridges and for Buttresses to solid Work. *Evelyn's Parallel*.

PILE, [in *Architecture*] as a Pile of Building, a great Mass or Body or Building.

PILES, [in *Architecture*] huge Stakes ramm'd into the Earth in order to render a Foundation solid to be built upon in marshy Ground.



PILE, in Heraldry, signifies an *Ordinary*, consisting of a Two-fold Line, formed after the Manner of a Wedge; being probably something like the Figure of the *Roman Pilum*, which was a tapering Dart, about five Foot long, and sharpened at the Point with Steel. The *Pile* is born *inverted*, *engrailed*, &c. like other *Ordinaries*, and issues indifferently from any Point of the Verge of the *Escutcheon*.

He beareth a *Pile Gules*, by the Name of *Chandois*.

PILLAGE, [in *Architecture*] is sometimes used for a square Pillar; that stands behind a Column to bear up the Arches.

PILLAR, or *Column*, in Architecture, is one of the principal Things in which the Beauty and Proportion of a Fabrick doth consist. A *Pillar* hath three Parts, the *Pedestal*, the *Shaft* or *Pillar* it self, and the Ornaments: And each of these is again subdivided into three other Parts; the *Pedestal* hath its *Base*, *Dye*, and *Cornich*; the *Pillar* its *Base*, *Shaft*, and *Capital*; and the Ornaments have their *Architrave*, *Frieze*, and *Cornich*.



**PILLASTERS**, in Architecture, signify Square Pillars, that usually stand behind Columns to bear up Arches: They have the very same Dimension, Chapter, and Base, with the Columns, according to their several Order. When these *Pillasters* do not stand alone by themselves, they are usually made to jet out of the Wall, a third part or a quarter of their Breadth, with respect to the Variety of different Works: So that some of them project out only a sixth or an eighth part, and they are generally as broad at top as at bottom.

**PILLOW**, is that Piece of Timber in a Ship whereon the Boltsprit beareth or resteth at its coming out of the Hull, aloft, close by the Stem.

**PINEALIS Glandula.** See *Conarium*.

**PINGUEDO**, the same with *Adeps*, or the Fat of Animals. See *Adeps*.

**PINION**, in a Watch, is that lesser Wheel which plays in the Teeth of another. Its Notches (which are commonly 4, 5, 6, 8, &c.) are called *Leaves*, and not *Teeth*, as in other Wheels.

**PINION of Report**, is that *Pinion* in a Watch, which is commonly fixed on the Arbor of the Great Wheel, and in old Watches used to have commonly but four Leaves: It driveth the *Dial Wheel*, and carrieth about the *Hand*.

The Quotient or Number of Turns to be laid upon the *Pinion of Report* is found by this Proportion: As the Beats in one Turn of the Great Wheel, to the Beats in an Hour: So are the Hours of the Face of the Clock, (*viz.* 12 or 24,) to the Quotient of the Hour-Wheel, or Dial-Wheel, divided by the *Pinion of Report*, *i. e.* the Number of Turns which the *Pinion of Report* hath in one Turn of the Dial-Wheel; that is, in Numbers.

$$26928 : 20196 :: 12 : 9.$$

Or rather thus:

As the Hours of the Watch's going, are to the Numbers of the Turns of the Fusy :: so are the Hours of the Face, to the Quotient of the *Pinion of Report*.

If the Hours be 12, then  $16 : 12 :: 12 : 9$ .

But if 24, the Proportion is  $16 :: 12 : 24 : 18$ .

*N. B.* This Rule may serve to lay the *Pinion of Report* on any other Wheel, thus:

As the Beats in one Turn of any Wheel to the Beats in an Hour :: so are the Hours of the Face, or Dial-plate of the Watch to the Quotient of the Dial-Wheel, divided by the *Pinion of Report* fixed on the Spindle of the aforesaid Wheel.

**PINK**, is a Vessel used at Sea mastcd and rigged like other Ships, but only she is built with a round Stern, the Bends and Ribs compassing so as that her Sides bulge out very much; wherefore these *Pinks* are difficult to be boarded, and also are made to carry greater Burdens, than others. They are often used fore Store-Ships, and Hospital-Ships, in the Fleet.

**PINNA Auris**, is the upper and broader Part of the Ear called the Wing.

**PINNACE**, is a small Vessel, with a Square Stern, going with Sails and Oars, and carrying three Masts; and is used as a Scout for Intelligence, and for Landing of Men, &c. also one of the Boats belonging to a great Man of War, which serves to carry the Officers to and from the Shoar, is called the *Pinrace*.

**PINNACLE**, [in Architecture] the Top or Roof of a House, which terminates in a Point.

**PINNATA Folia**, in Botany are such Leaves of Plants as are deeply jagged, cut, or indented in, and which have their parts resembling Feathers.

**PINTLE**, [in Gunnery] an Iron Pin, serving to keep a Cannon from recoiling.

**PINTLES**, [in a Ship] are the Hooks by which the Rudder hangs to the Stern-post.

**PIONEERS**, are such Kinds of Labourers as are taken up for the use of an Army, to cast up Trenches, and undermine Forts.

**PIPE**, in Law, is a Roll in the Exchequer, otherwise called the *Great-Roll*. See *Clerk of the Pipe*.

**PISCES**, is the twelfth and last Sign of the Zodiack, being a Constellation consisting of 35 Stars.

**PISCES Meridianus**, a Southern Constellation, containing 12 Stars.

**PISCIVOROUS Animals**, are such as feed on Fish. See *Birds*.

**PISTIL**, or *Pistillum* [in Botany] a small upright Part in the middle of the *Calyx*, or the Leaves of Flowers, called also the Style.

**PISTON**, [in Mechanicks] a Part or Member in several Machines, particularly *Pumps*, *Air-Pumps*, *Syringes*, &c. called also *Embolus*, or vulgarly *Suckers*.

**PITCH**, is a Word used by Architects and Builders in these Senses. Sometime *Paving* is called *Pitching*: But usually they understand it by the Angle which a Gable-end, and consequently the whole Roof of a Building is set to. If the Length of each *Rafter* be  $\frac{3}{4}$  of the Breadth of the Building, then they say that Roof is of a *True Pitch*: But if the Rafters are longer, they say 'tis a *high* or *sharp pitch'd Roof*; if shorter, they call it a *low* or *flat pitch'd Roof*.

**PITHIAS**, or *Pithites*, with some Writers, is the Name of a Comet, or rather Meteor, of the Form of a Tub: Of these there are divers Kinds, *viz.* some of an *Oval* Figure, others like a Tun or Barrel set perpendicular, and some like one inclined, or cut short off; others having a Hairy Train or Bush, &c.

**PITUROIDES**, a Settling in the Urine like Bran. *Blanchard*.

**PITUITA.** *Vid. Phlegma*.

**PITUITARIA Glandula.** *Vid. Glandula Pituitaria*.

**PIVOT**, a Foot or Shoe of Iron or other Metal, commonly in a conical Figure, or terminating in a Point, by which a Body that turns round, bears upon that that is fixed, and at rest, and performs its Circumvolution.

**PLACARD**, is a Licence whereby a Man is permitted to shoot in a Gun, or use unlawful Games.

**PLACARD**, [in Architecture] the Decoration of the Door of an Apartment, which consists of

2 Cham-



a Chambranle, crown'd with its Freez and Gorge; and its Cornice is sometimes supported by Consoles.

PLACE, is that part of Space which any Body takes up; and with relation to Space is either absolute or relative. As Mr. *Lock* observes.

PLACE also is sometimes taken for that Portion of Infinite Space, which is possessed by, and comprehended within the Material World, and which is thereby distinguished from the rest of the *Expansion*.

PLACE is usually distinguished into *Internal Place*, which properly speaking, is that Part of Space which any Body takes up or fills; and *External Place*, which according to *Aristotle*, is determined by the Surfaces or Confines of the Adjoining or Ambient Bodies: But it is better divided into *Absolute*, which is the former *Internal Place*; and into *Relative Place*, which is the Apparent Secondary or Sensible Position of any Body, according to the Determination of our Senses, with respect to other Contiguous or Adjoining Bodies.

PLACE of *Arms*, when taken in the general, is a strong City which is pitch'd upon for the Magazine of an Army. But a

PLACE in *Fortification*, usually signifies the Body of a Fortrefs. And a

PLACE of *Arms in a Garrison*, is a large open Spot of Ground in the Middle of the City, where the great Streets meet, or else between the Ramparts and the Houses, for the Garrison to rendezvous in, upon any sudden Alarm, or other Occasion. And the

PLACE of *Arms of a Trench, or of an Attack*, is a Post near it, shelter'd by a *Parapet* or *Epaulement*, for Horse and Foot to be at their Arms, to make good the Trenches against the Sallies of the Enemy. These Places of Arms are sometimes covered by a *Rideau* or Rising-ground, or else by a *Cavin* or Deep Valley, which saves the Trouble of fortifying them by Means of Parapets, Fascines, Gabions, &c. They are always open in the Rear, for their better Communication with the Camp. When the Trench is carried on as far as to the *Glacis*, they make it very wide, that it may serve for a Place of Arms. Also the

PLACE of *Arms of a Camp*, is a spacious Piece of Ground at the Head of the Camp, to draw out the Army in Order of Battle. But the

PLACE of *Arms of a Troop of Horse, or of a Company of Foot in the Camp*, is that Spot of Ground on which the Troops or Company draws out.

PLACE *Geometrick*, is a certain Bound or Extent wherein any Point may serve for the Solution of a *Local* or *Indetermined Problem*. All the Points of a *Geometrick Place*, have the same Relation to the Points of the Right Line correspondent thereunto.

PLACE *Geometrick*. The Ancients called their *Locus* or Place, ἀναλυόμενον, i. e. *Resolutus*, and the Order of their Writings about it, according to *Pappus*, is this, (1.) *Euclidis Datorum, Lib. 1.* (2.) *Apollonii λόγος ἀναλυόμενος, or de Rationis Sectione, Libri 2.* (3.) The same Author's *ἡρώδης ἀναλυόμενος, of the Section of a Space, 2 Books.* (4.) His two Books of *Tactiones* (ἐπαφοί.) (5.) *Euclid* his 3 Books of *Porismata*. (6.) *Apollonius* his *νύσεων, or of Inclinations, Book 2.* (7.) The same Wri-

ter's two Books of *Loca plana, τόπων ἐπιπέδων.* (8.) His eight Books of *Conicks.* (9.) *Aristæus* his five Books *τόπων στερεών, or of Solid Places.* (10.) *Euclid* his two Books of *Places ad Superficiem.* (11.) *Eratosthenes*'s two Books *de Medietatibus.* Of all which only *Euclid*'s *Data*, and four Books of *Apollonius* his *Conicks*, are left now in Being.

See also *J. Craig's Tractatus Mathematicus de Fig. Curvilinearum Quadraturis; & de Locis Geometricis.* Lond. 1693. 4to.

PLACE *Plane*, is when the Point resolving the Problem, is in the Periphery of a Circle: And then 'tis called, *Locus ad Circulum.* Thus v. gr. *A Circle and any one of its Diameters being given, to find a Point without it, but on the same Plane with it; from whence a Right Line being drawn to one of the Ends of the Diameter, that Line shall be bisected by the Circumference of the Circle.*

PLACE *simple*, or *Locus ad Lineam rectam*, as the Geometers call it, is when the Point that resolves any Problem is in a Right Line. As, *To find the Centre of a Circle, whose Periphery shall pass thro' the Ends of a Right Line given in Magnitude and Position:* For such Centre will be in a Right Line. But a

PLACE *Solid*, is when the Point is in one of the *Conick Sections*: Thus, *To find the Centre of a Circle which shall touch both a Line given in Position, and also another Circle given in Position and Magnitude:* There must be a Point found in the Periphery of a *Parabola*, the *Focus* of which, is the Centre of the Circle given, when the given Line and Circle touch one another. Lastly, a

PLACE *Surfsolid*, is when the Point is in the Circumference of a Curve of an higher Gender than the *Conick Sections*; as having a Point and a Right Line given on a Plane, to find on that Plane another Point beyond that given Line; so that a Right Line drawn thro' those 2 Points, shall have its Part comprehended between the second Point and the given Line, also given itself.

PLACE of the *Sun, Star, or Planet*, is the Sign of the *Zodiack*, and Degree of it, which the Planet is in; or it is that Degree of the *Ecliptick* reckoned from the Beginning of *Aries*, which the Planets or Stars Circle of Longitude cutteth; and therefore is often called, *The Longitude of Sun, Planet, or Star.*

And 'tis found by this Proportion:

As Sine of Sun's greatest Declination is  $23^{\circ} 30'$ . — — — } 9.6006997

To Sine of this present Decl.  $23^{\circ} 15'$  — 9.5963154

So is Radius — — — 10

To the Sine of his Longitude  $81^{\circ} 52'$  9.9956157

Which if the Declination were North, will be in  $20^{\circ} 52'$  of *Gemini*; but if the Sun had South Declination, his Place would be in  $20^{\circ} 52'$  of *Capricorn*.

PLACE, [in *Opticks*] is the Point to which the Eye refers an Object.

*Optick PLACE of a Star*, [in *Astronomy*] is a Point in the Surface of the mundane Sphere, wherein a Spectator beholds the Centre of the Star.

True



*True or Real Optick PLACE* [in *Astronomy*] is that Point of the Surface of the Sphere, wherein a Spectator placed in the Centre of the Earth, beholds the Centre of the Star or Phænomenon. Or it is a Point among the fixed Stars which is determined by a Line drawn from the Centre of the Earth through that of the Star, and terminated among the Stars.

*Apparent Optick PLACE, Visible Optick Place*, [in *Astronomy*] is that Point of the Surface of the Sphere in which a Spectator placed on the Surface of the Earth sees the Centre of the Star. Or it is a Point found by a Line that passes from the Spectator's Eye through the Star, and that terminates in the Sphere of the Star.

*PLACE Apparent of a Planet*, is a Point in the Starry Heaven which is found by a Right-Line passing from the Spectator's Eye on the Earth's Surface, and terminated at the other End amongst the fixed Stars. In the Figure under the Word *Parallax* in Vol. I. If *A* be the Centre of the Earth, and *B* a point on its Surface; let *C* represent the Moon, then will *G* be her true and *H* her apparent Place in the Starry Heaven.

*PLACE True of a Planet*, in Astronomy, is that point amongst the fix'd Stars which is found by imagining a Right Line to be drawn from the Earth's Centre thro' the Planet, and terminated at the other End in the Starry Heaven.

*Eccentric PLACE of a Planet in its Orbit*, [in *Astronomy*] is that place or point of its Orbit, in which a Planet would appear if seen from the Sun.

*Geocentrick PLACE*, [in *Astronomy*] is that Point of the Ecliptick to which a Planet view'd from the Earth is referr'd.

*Heliocentrick PLACE of a Planet*, [in *Astronomy*] is that point of the Ecliptick to which a Planet view'd from the Sun is referr'd. Or it is its Place reduced to the Ecliptick, or the *eccentric Place in the Ecliptick*.

*The PLACE of the MOON*, [in *Astronomy*] is that Point of her Orbit, in which she is found at any Time.

*PLACENTA Uterina*, called by some *Hepar Uterinum*, from its Colour, which is like that of the Liver, as it is also something in Substance: But it comes nearer to that of the Spleen. It is soft, and hath innumerable Fibres, and small Vessels, and its Parenchyma is Glandulous almost every where. In Women it is Circular, but with some Inequality in its Circumference; in the Middle it is about two Fingers thick, but is thinner towards the Edges, and is about a Span, or a quarter of a Yard over, from one Side to the other, when the *Fœtus* is mature for the Birth: It is hollowed and smooth within, next the *Fœtus*, and grows every where firmly to the Chorion; but without, next the Womb, 'tis very unequal, having many Protuberances, by which it adheres to the Womb, tho' to what Part of it, is not agreed. When there is more than one *Fœtus*, 'tis sometimes double, trebble, &c. and sometimes but one with so many distinct Partitions in it. It grows not from the Womb originally, but its Rise is from the *Chorion*, which about the 9th Week, in Women, sends forth a downy Substance, which soon grows into Knobbs, turns reddish, and then adheres to the Womb conspicuously, about the twelfth or thirteenth Week.

It hath Vessels from a double Original, some from the Womb, and some from the *Chorion* immediately, and mediately from the *Fœtus*. From the Womb it receives Arteries, Veins, Nerves, and Lymphæducts; all which, tho' they be very large and conspicuous in the Womb, and even in that Place where the *Placenta* joins to it, yet they are but very small Capillaries in the *Placenta* itself, and are dispersed only thro' that Side of it which is next the Womb. The Vessels that come from the *Chorion* are Arteries and Veins; and, as Dr. *Wharton* saith, Lymphæducts also. From the *Fœtus*, thro' the *Chorion*, it receives the Umbilical Vessels of the *Fœtus*: For the first Months of the Pregnancy it sticks most firmly to the Womb; but as the *Fœtus* grows mature for the Birth it loosens by Degrees, and at last, like ripe Fruit from the Tree, falls off from the Womb, and makes part of the After-burthen or Birth.

*PLACITUM*, [in *Law*] a Sentence of the Court or an Opinion, Ordinance, or Decree.

*PLADAROSIS*, [*πλαδάρωσις*, Gr.] are little soft Tumours which grow under the Eye-lids.

*PLAFOUND, Platfound*, [in *Architecture*] the Cieling of a Room, whether it be Flat or Arch-ed; lined either with Plaister or Joinery, and oftentimes enriched with Paintings, &c.

*PLAIN Chart*, is the Plat or Chart that Seamen sail by, whose Degrees of Longitude and Latitude are made of the same Length.

*PLAIN Sailing*, is the Art of finding all the Varieties of the Ship's Motion on a Plain, where all the Meridians are made Parallel, and the Parallels at Right Angles with the Meridians, and the Degrees of each Parallel equal to those of the Equinoctial; which, tho' notoriously false in itself, supposing the Earth and Sea to be a Plain Flat, and each Parallel equal to the Equinoctial; yet by laying down Places accordingly, and breaking a long Voyage into many short ones, a Voyage may pretty well be perform'd by it, near the same Meridian.

In *Plain Sailing* 'tis imagin'd, that by the *Rhumb-Line*, *Meridian*, and *Parallel of Latitude*, there always will be formed a Right-angled Triangle; and that so posited, as that the Perpendicular may represent part of the Meridian or North and South Line, containing the *Difference of Latitude*: The Base of the Triangle represents the *Departure*; and the Hypothenuse the *Distance sailed*; the Angle at the Top is the *Course*, and the Angle at the Base the *Complement of the Course*: Any two of which, with the Right Angle being given, the Triangle may be protracted, and the other three Parts found: As in the following Examples.

#### C A S E I.

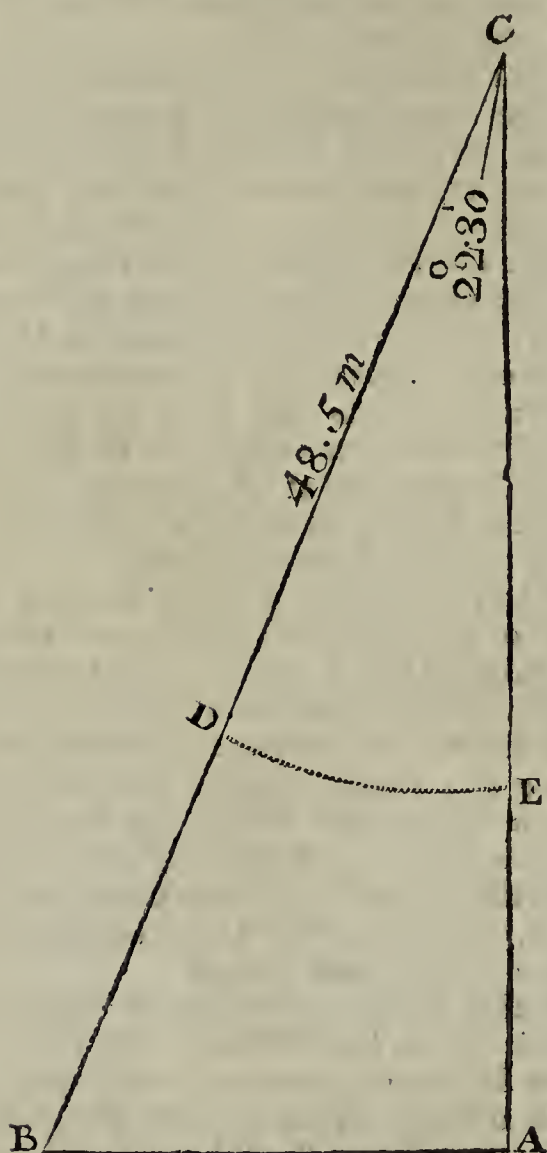
*The Course and Distance given, to find the Difference of Latitude, and Departure from the Meridian.*

Admit a Ship from the Latitude 50° 10' North, sails S. S. W. 48. 5 Miles: I require the Latitude she is in, and her Departure or Separation.



By Gunter's Scale.

Geometrically.



Draw A C the South and North Line, and with 60 Degrees from the *Line of Chords* from C, (because the Ship sails Southward) describe D E, which make equal to 22 Degrees 30 Minutes the Course, and draw C B, which make also equal to 48.5 from any *Line of Equal Parts*: Then let fall from B, B A, perpendicular to the Meridian; so is the Triangle compleated, and the Lines C A, B A, may be measured from the same Scale.

By the Logarithms.

As the Radius	—	—	10.00000
Is to the Distance run, B C 48.5	—	1.68574	
So is the Sine of the Course 22° 30'	—	9.58283	
To the Departure Westing 18° 56'	—	1.26857	

Then again :

As the Radius	—	—	10.00000
Is to the Distance B C 48.5 Miles	—	1.68574	
So is Co-sine of the Course S. 67° 30'	—	9.96561	
To the Difference of Latitude 44.8	—	1.65135	

From the Departed Latitude 50° 10' North.  
Subtract the Difference of Lat. 00 45

Remainder is the present Latit. 49 25

The Extent of the Compasses from S. 90 Degrees, to S. 22 Degrees 30 Minutes on the *Line of Sines*, will reach from 48.5 back to 18.6, on the *Line of Numbers*.

And,

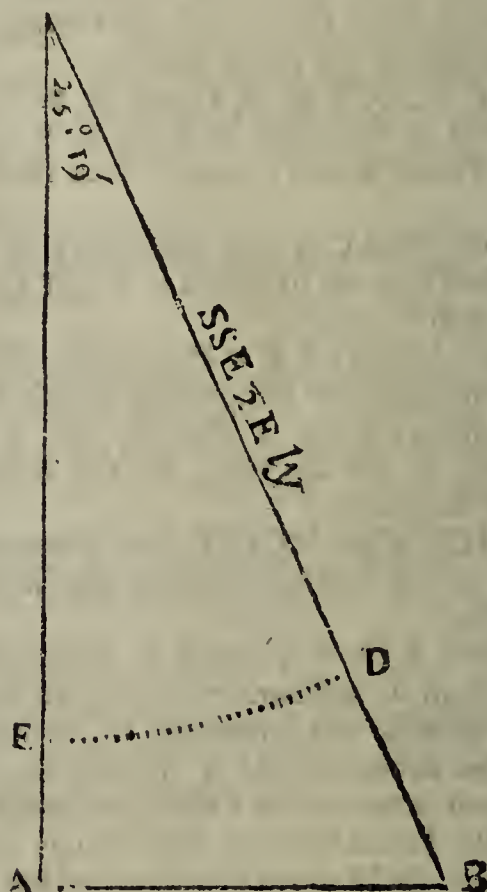
The Extent from S. 90 Degrees, 00 Minutes, to the S. 67 Degrees, 30 Minutes, on the *Line of Sines*, reaches from 48.5 backwards to 44.8, on the *Line of Numbers*.

## C A S E II.

The Course and Difference of Latitude being given ;  
to find the Departure and Distance sailed.

Admit a Ship sail from Latitude 48 Degrees 30 Minutes S. S. E.  $\frac{1}{4}$  Easterly till she be in Latitude 47 Degrees 21 Minutes : I demand the Departure and Distance sailed.

Geometrically.



Draw the North and South Line C A, and subtracting the Latitudes one from another, it leaves 69 Minutes for their Difference; make C A equal to 69, from the *Line of Equal Parts*; from C with 60 Degrees from the *Line of Chords*, describe D E, which make equal to 25 Degrees 19 Minutes; draw C D, and raise the Perpendicular A B, which compleats the Triangle B A C, whose required Parts may be measured by the Scale.



*By the Logarithms.*

As Co-sine of the Course S. $54^{\circ} 41'$	9.956148
Is to the Difference of Lat. 69 Miles	1.838849
So is the Radius — — —	10.000000

To the Distance sailed B C 76.3	1.882701
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Then,

As the Radius — — —	10.000000
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Is to the Distance sailed C B 76.3	1.882524
So is the Sine of the Course $25^{\circ} 19'$ —	9.631058

To the Departure A B 32.6 —	1.513582
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*By Gunter's Scale.*

The Extent from S.  $64^{\circ}$  Deg.  $41$  Min. to S.  $90^{\circ}$  Deg.  $00$  Min. on the *Line of Sines*, will reach from 69 to 76.3 on the *Line of Numbers*.

And,

The Extent from S.  $90^{\circ}$  Deg.  $00$  Min. to S.  $25^{\circ}$  Deg.  $19$  Min. on the *Line of Sines*, will reach from 76.3 to 32.6 on the *Line of Numbers*.

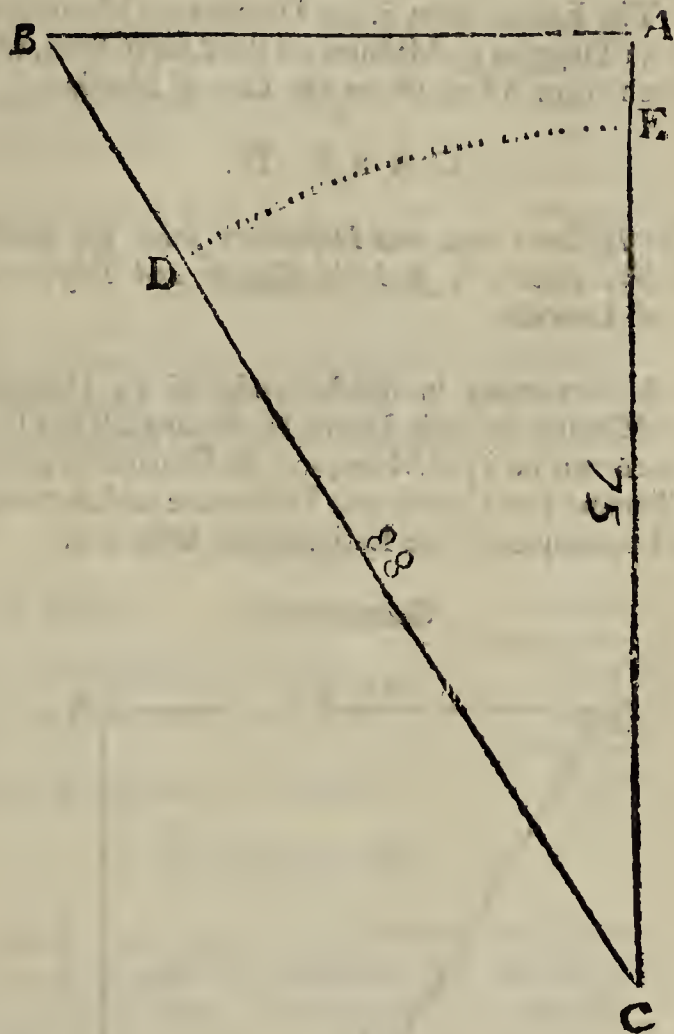
### C A S E III.

*The Difference of Latitude and Distance sailed given; to find the Course and Departure.*

Admit a Ship sail from Latitude  $42^{\circ}$  Degrees  $15$  Minutes North, on some Point between the North and West 88 Miles, and then finds herself in Latitude  $43^{\circ}$  Degrees  $30$  Minutes: I demand her Course and Departure.

From — —	$43^{\circ} 30'$
Subtract — —	$42 15$
Remains — —	$1 15$
	$60$
	$75 = \text{Diff. Lat.}$

*Geometrically.*



Draw the Meridian A C, which let be made equal to 75, raise the Perpendicular B A; from C with 88 cross B A in B; draw B C from C, with 60 from the *Chords* describe D E, which measured on the *Chords* or *Rhumbs*, shews the *Course*;  $2\frac{3}{4}$  Points from the North-westward, viz. N.N.W.  $\frac{3}{4}$  Westerly.

*Note,* That the Sides of Plain Triangles are measured by the Line of Equal Parts, but the Angles, by the Line of Chords.

*By the Logarithms.*

As the Distance run B C 88 —	1.94448
Is to the Radius — —	10.00000
So is the Difference of Lat. C A 75	1.87506
To the Co-sine of the Course $58^{\circ} 27'$	9.933058

Whose Complement  $31^{\circ}$  Degrees  $33$  Minutes is  $2\frac{3}{4}$  Points from the Meridian, which is N.N.W.  $\frac{3}{4}$  Westerly.

*By Gunter's Scale.*

The Extent from 88 to 75 on the *Line of Numbers*, reaches from S.  $90^{\circ}$  Degrees  $00$  Minutes, to  $58^{\circ}$  Degrees  $27$  Min. on the *Line of Sines*.

Then,

As the Radius — —	10.00000
Is to the Distance run C B 88 —	1.94448
So is the Sine of the Course $31^{\circ} 33'$	9.71870
To the Departure A B 46 Miles West	1.66318

By



By Gunter's Scale.

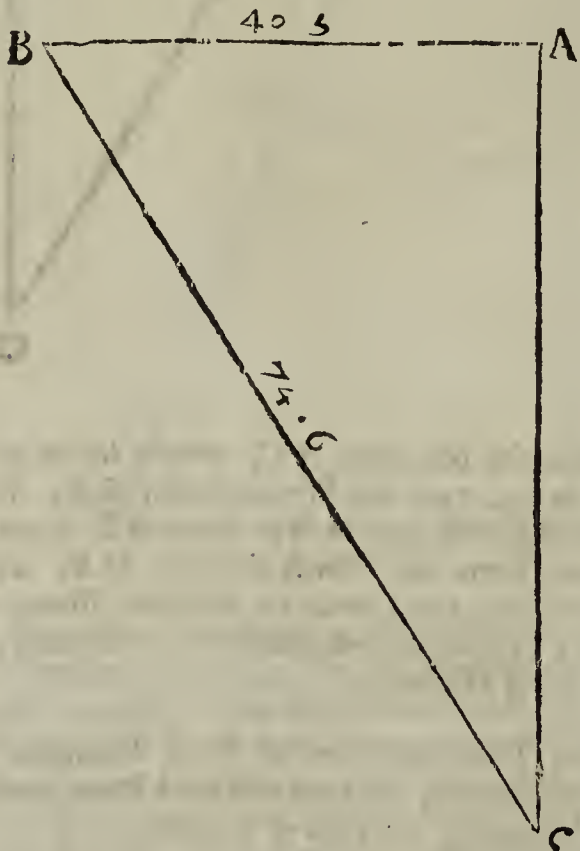
The Extent from S. 90 Degrees 00 Minutes to S. 31 Degrees 33 Minutes on the *Line of Sines*, will reach from 88 to 46 on the *Line of Numbers*.

#### CASE IV.

The Distance run, and Departure from the Meridian given; to find the Course and Difference of Latitude.

A Ship being in the Latitude of 59 Degrees 00 Minutes N. sails North Westward till her Distance run be 74.6 Miles, and the Departure 40.5: I demand the Course and Difference of Latitude, and consequently the Latitude the Ship is in.

Geometrically.



Draw the Meridian A C on A, (because the Ship sails Northward) raise the Perpendicular B A, laying thereon 40.5 Miles, the Departure from A to B; then take 74.6 in your Compasses, from B cross the Meridian A C in C, and draw B C.

By Logarithms.

As the Distance run B C 74.6 Miles	1.87273
Is to the Radius — — —	10.00000
So is the Departure B A 40.5 —	1.60745
To the Sine of the Course 32° 53' —	9.73472

By Gunter's Scale.

The Extent from 74.6 to 40.5 on the *Line of Numbers*, reaches from S. 90 Degrees 00 Minutes, to S. 32 Degrees 53 Minutes on the *Line of Sines*.

Then again:

As the Radius — — —	10.00000
Is to the Distance B C 74.6 —	1.87273
So is the Co-sine of the Course 57° 7' —	9.92416
To the Difference of Latitude 62.6 —	1.79689

Which turned into Degrees, is 1 Degree 3 Minutes, and is to be added to 59 Degrees 00 Minutes, the Latitude she departed from, because she raises the Pole; the Sum 60 Degrees 3 Minutes the Latitude the Ship is in.

By Gunter's Scale.

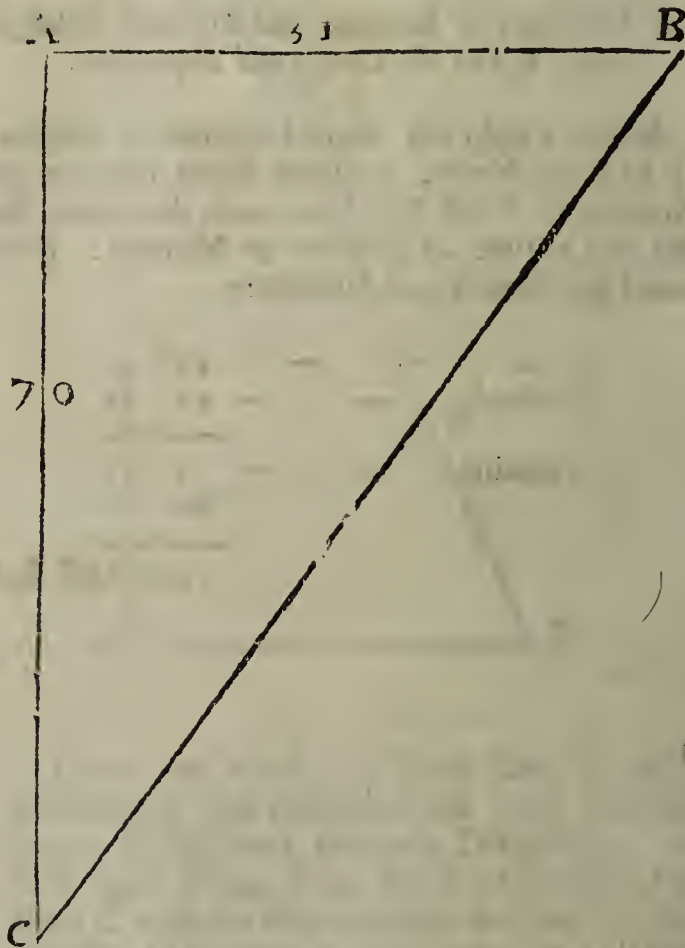
The Extent from S. 90 Degrees 00 Minutes, to S. 57 Degrees 7 Minutes, on the *Line of Sines*, will reach from 74.6 to 62.6 on the *Line of Numbers*.

#### CASE V.

The Difference of Latitude and Departure, from the Meridian given; to find the Course and Distance.

A Ship from Latitude 59 Degrees 00 Minutes North, sails North Eastward till she has altered her Latitude 1 Degree 16 Minutes or 70 Miles, and is departed from the Meridian 51 Miles: I demand the Course and Distance.

Geometrically.



Draw A C, which make equal to 70 Miles; raise the Perpendicular A B, which make also equal to 51 Miles, draw B C.

By the Logarithms.

As the Difference of Lat. A C 70 Miles	1.845098
Is to the Radius — — —	10.000000
So is the Departure A B 51 Miles —	1.707570
To the Tangent of the Course 36° 5' —	9.862472

By



By Gunter's Scale.

The Extent from 70 to 51 on the *Line of Numbers*, will reach from Tangent 45 Degrees 00 Minutes, to the Tangent 36 Degrees 5 Minutes on the *Line of Tangents*.

Then,

As the Sine of Course $36^{\circ} 5'$	—	9.77008
Is to the Departure 51	—	1.70757
So is the Radius	—	10.00000
To the Distance 86.5 Miles	—	1.93749

By Gunter's Scale.

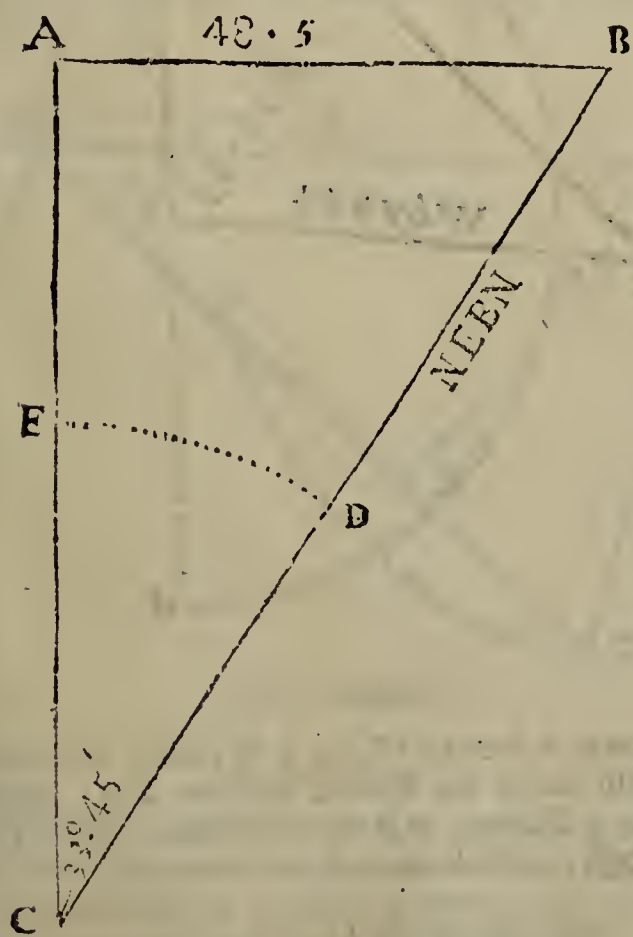
The Extent from S.  $36^{\circ} 5'$  Minutes, to the S.  $90^{\circ} 00'$  Minutes on the *Line of Sines*, will reach from 51 to 86.5 on the *Line of Numbers*.

### CASE VI.

The Course and Departure given; to find the Distance and Difference of Latitude.

A Ship from the Latitude of 48 Degrees 30 Minutes N. sails N. E. by N. till her Departure from the Meridian be 48.5: What is the Distance sailed, and Difference of Latitude?

Geometrically.



Draw the Meridian AC, from C with 60 Degrees of the Chord describe DE, which make equal to  $33^{\circ} 45'$ , and let the Perpendicular AB be 48.5 from the *Equal Parts*.

By the Logarithms.

As the Sine of the Course $33^{\circ} 45'$	—	9.744739
Is to the Departure AB 48.5	—	1.685741
So is the Radius	—	10.000000
To the Distance CB 87.3	—	1.941002

By Gunter's Scale.

The Extent from S.  $33^{\circ} 45'$  Minutes, to S.  $90^{\circ} 00'$  Minutes on the *Line of Sines*, will reach from 48.5 to 87.3 on the *Line of Numbers*.

Then,

As the Radius	—	10.00000
Is to the Distance run 87.3	—	1.94101
So is the Co-sine of the Course S. $56^{\circ} 15'$	—	9.91984
To the Difference of Latitude 72.	—	1.86085

By Gunter's Scale.

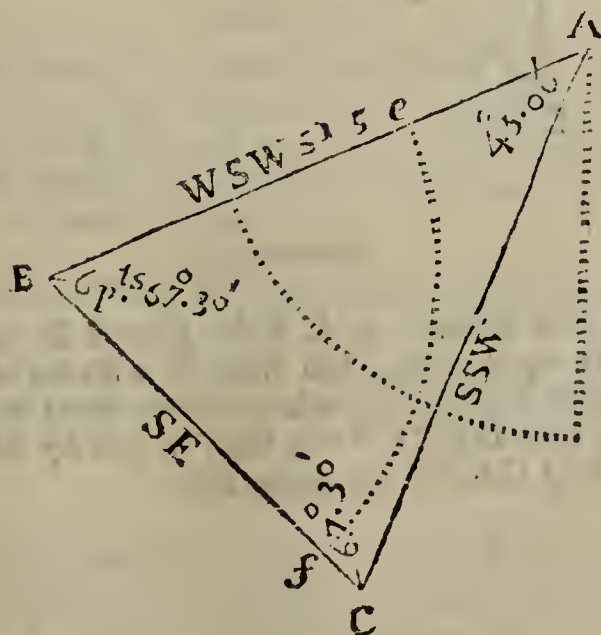
The Extent from S.  $90^{\circ} 00'$  Minutes, to S.  $56^{\circ} 15'$  Minutes, on the *Line of Sines*, reaches from 87.3 to 72.6 on the *Line of Numbers*.

These are the Seven usual Cases of *Plain Sailing*, which you see are all performed by the Knowledge of Rectangled Plain Trigonometry. The Doctrine of *Oblique Plain Triangles*, is not of such Necessary Use in Sailing, as that of Right-angled ones is: But however, I have here singled out some of the most Useful Cases of it, as follows.

Plain Sailing, where the Application of Oblique Triangles is required.

Example.

Coasting along the Shore, I set an Head-land C, bearing off me S. S. W. I sail W. S. W. 51.5 Miles to B, and then the Head-land C bears S. E. from me: I demand my several Distances to the Head-land.





*Geometrically.*

From A draw a S. S. W. Line, as A C, and a W. S. W. Line, as A B, and make AB = 51.5 Miles; then from B, with 60 Degrees of the Chords, describe *ef*, which make equal to six Points, and draw Bf.

*By the Logarithms.*

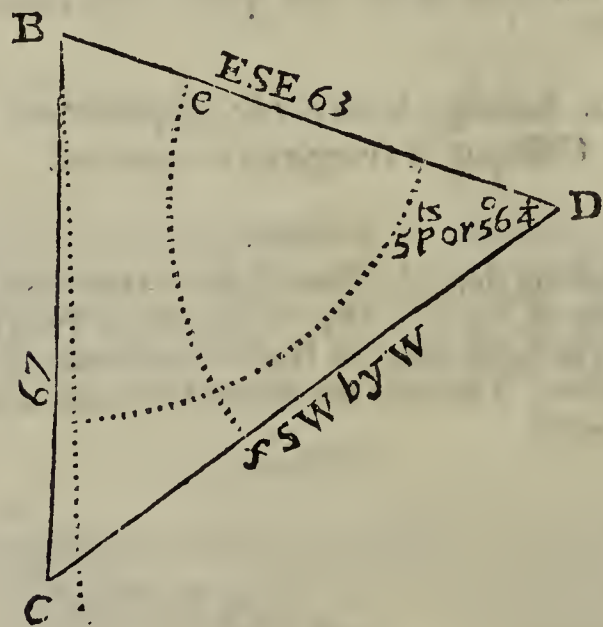
In the Triangle B A C, given BA 51.5 Miles and all the Angles, viz. The Angle A 45 Degrees, Angle B 67 Degrees 30 Minutes, and the Angle C 67 Degrees 30 Minutes; required B C and C A.

As the Sine of the Angle C 67° 30'	9.9656153
Is to the Distance A B 51.5 Miles	1.7118072
So is Sine of the Angle at A 45° 00'	9.8494850
	<hr/>
	11.5612922
To the Distance B C 39.4	1.5956769

And since the Angle B, is equal to the Angle C, the Side A C, will be equal to the Side A B.

*Example II.*

A Ship in the Parallel of 46 Degrees North at B, descies a Head-land at C, distant from her 67 Miles; she Sails E. S. E. 63 Miles to D, and then the Head-land at C bears S. W. by W. from her: How did the Head-land bear from the Ship when she was at B? And how far is it distant from her, now she's at D?

*Geometrically.*

From B draw an E. S. E. Line B D, which make equal to 63, and from D with 60 of the Chords describe *ef*, which make equal to 56° 15', draw Df C: Then from B with 67 Miles, cross D C in C, and draw B C.

*By the Logarithms.*

As the Distance B C 67 Miles <i>Ar. co.</i>	8.17392
Is to the Sine of the Angle D 56° 15'	9.91984
So is the Distance failed B D, 63 Miles	1.79934
	<hr/>
To the Sine of the Angle C 51° 26'	9.89310

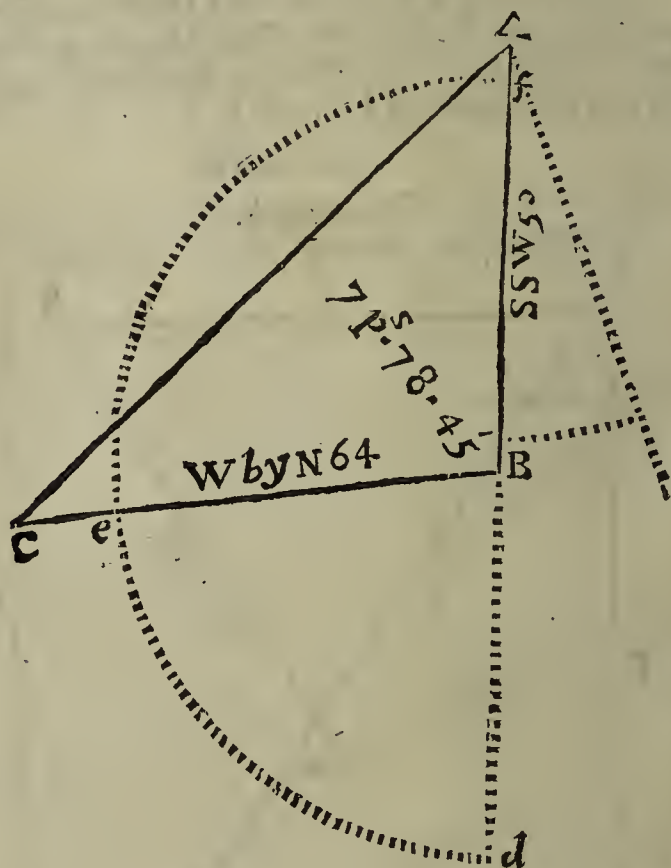
Now  $56^{\circ} 15' + 51^{\circ} 26' = 107^{\circ} 41'$ , whose Complement to  $180^{\circ}$ , is  $72^{\circ} 19' =$  Angle B,  $6\frac{1}{2}$  Points, which added to E. S. E. gives the Bearing of C to be S.  $\frac{1}{2}$  Westerly near.

*Then,*

As the Sine of the Angle D, 56° 15'	9.919846
Is to the Distance B C 67 Miles	1.826074
So is the Sine of the Angle B 72° 19'	9.978978
	<hr/>
	11.805052
To the Distance D C 76° 8'	1.885206

*Example III.*

If I fail S. S. W. 50 Miles, then W. by N. 64 Miles; I demand the Course and direct Distance from the Place of Departure?

*Geometrically.*

Draw AB = 50 M. a S. S. W. Line, and from B with 60 of the Chords describe *def*; make *de* = 7 Points, or *fe* = 9 Points, draw B C through e, which make equal to 64 M.

*By the Logarithms.*

In the Triangle C B A, there's given the two Sides C B and B A, and the contained Angle C B A, 7 Points, to find the Angles A and C, and the third Side C A.

C B =	64
A B =	50
	<hr/>
Sum. =	114
	<hr/>
Diff. =	14



PLA

Which added to A C 65, makes 84.2, whose half is 42.1 is A E.

Then,

As A B 58 Miles, Ar. Compl.	8.236571
Is to the Radius	10.000000
So is A E 42.1.	1.624282

Which subtracted from 50 Deg. 37 Min. there remains 42 Deg. 7' =  $\angle C$ ; but 8 Deg. 30 Min. added to 50 Deg. 37 Min. makes 59 Deg. 7 Min. =  $\angle A$ ; and since A B is a S. S. W. Line, A C is W. by S.  $\frac{1}{4}$  Westerly.

To the Co-sine of the Ang. A.  $43^{\circ} 28'$  9.860853

That is,

S. E. 1 Deg. 32 Min. Easterly, the Course she steered.

Then for the Distance A C, say,

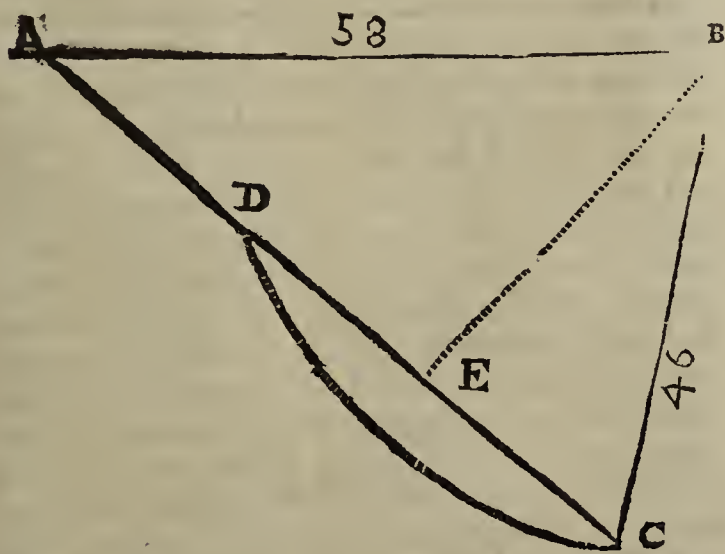
As the Sine of the Angle A  $59.7 = 9.9833595$

Is to the Distance B C 64 M. — 1.806180  
 So is the Sine of the  $\angle$  B, or its } 9.991573  
 Complement to  $180^\circ$ ,  $78^\circ 45'$

To the Distance A C<sub>73.2</sub> M. —  $\begin{matrix} 11.797753 \\ 1.864158 \end{matrix}$

*Example* IV.

Admit two Ports lying in the same Parallel or Latitude, to differ in Longitude 58 Miles; and a Ship having sailed from the Westermost, between the South and East 65 Miles, to be then 46 Miles from the Eastermost: I demand the Course she steered, and her Course to the Eastermost Port?

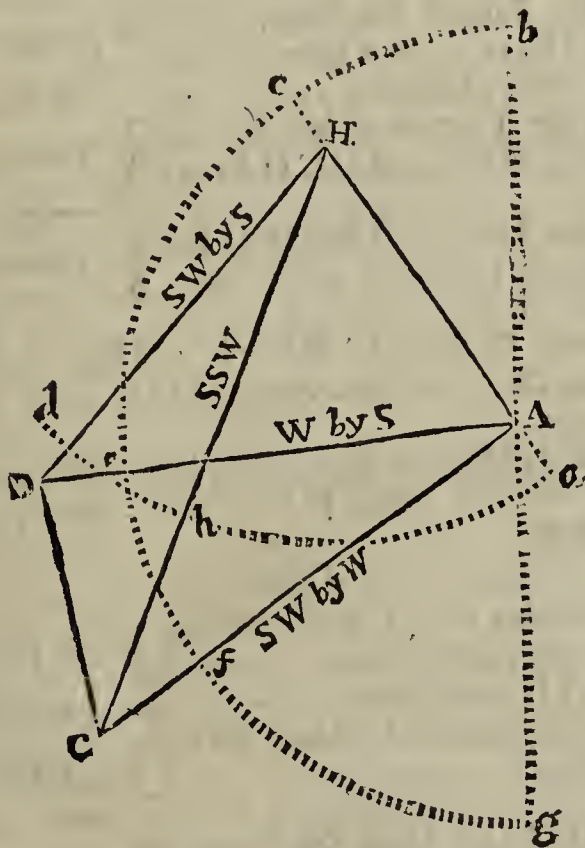


*Geometrically.*

Having drawn  $AB$  an East and West Line, and made it equal to 58 M. then from  $A$  with 65 M. describe an Arch, and with 46 M. from  $B$  cross that Arch in  $C$ , draw  $AC$  and  $BC$ .

*By the Logarithms.*

As A C 65 Miles	—	—	8.187086
Is to the Sum of the Distance A B and			} 2.017033
B C 104 Miles	—		
So is the Difference 12 Miles		—	1.079181
			<hr/>
To A D 19.2	—	—	1.283300



*Geometrically.*

First draw  $b A g$  a North and South Line, and with 60 of the Chords from  $A$  describe  $b e g$ ; then make  $g f = 5$  Points,  $g e = 7$  Points, and  $b c = 3$  Points; draw  $A f C$ ,  $A e D$ , and  $A H c$ , make  $A H = 40$  Miles.

Secondly, From H with 60 of the Chords describe  $ad$ , which make equal 6 Points; and also  $ab$  equal 5 Points; draw  $HbC$ ,  $HdD$ , and  $DC$ . Then is  $D$  one Head-land, and  $C$  the other.

*By the Logarithms.*

In the Triangle  $HAC$  given the Angle  $HAC = 8$  Points, the Angle  $AHC = 5$  Points, and the Angle  $AHC = 3$  Points, together with the Side  $HA = 40$  Miles to find the Side  $CH$ .

Therefore,



Therefore,

As the Sine of the Angle  $HCA$  }  $0.255261$   
 $33^\circ 45'$ , Ar. Compl. — — —  
 Is to  $AH$  40 Miles — — —  $1.602060$   
 So is the Sine of  $90^\circ = \angle HAC$  —  $10.000000$   
 To the Side  $HC$  72 Miles — —  $1.857321$

Then in the Triangle  $DHA$ , there's given Angle  $HAD = 6$  Points, the Angle  $AHD = 6$  Points, and the Angle  $HDA = 4$  Points, and the Side  $AH$  40 Miles to find the Side  $DH$ . Thus:

As the Sine of the Angle  $HDA$   $45^\circ$  }  $0.150515$   
 $00'$ , Ar. Compl. — — —  
 Is to the Side  $AH$  40 Miles — — —  $1.602060$   
 So is the Sine of the  $\angle HAD$   $67^\circ 30'$   $9.965615$   
 To  $DH$  52.3 Miles — — —  $1.718190$

Then in Triangle  $DHC$  there's given two Sides,  $CH = 72$  Miles, and  $DH$  52.3; and their contained Angle  $CHD = 1$  Point, to find the other two Angles  $HDC$ ,  $HCD$ , and the third Side.

As the Sum of the Sides,  $HC +$  }  $7.905528$   
 $HD$  124.3, Ar. Compl. — — —  
 Is to their Difference 19.7 — — —  $1.294466$   
 So is the Tangent of half the Sum }  $11.005954$   
 of  $\angle LHD$  and  $HCD$   $84^\circ 22'$  }  
 To the Tangent of half their Dif- }  $10.209548$   
 ference  $58^\circ 6'$  — — —

Now,  $84$  Deg.  $22$  Min.  $+ 58$  Deg.  $6$  Min.  
 $= 142$  Deg.  $28$  Min. Angle  $HDC$ .

But  $84$  Deg.  $22$  Min.  $- 58$  Deg.  $6$  Min.  $= 25$   
 Deg.  $16$  Min. Angle  $HCD = N.$  one quarter  
 Westerly.

Then,

As the Sine of the Angle  $HCD$  }  $0.369743$   
 $25^\circ 16'$ , Ar. Compl. — — —  
 Is to  $DH$  52.3 Miles — — —  $1.718190$   
 So is the Sine of the Angle  $DHC$  }  $9.290235$   
 $11^\circ 15'$  — — —  
 To  $DC$  23.9 Miles the Distance }  $1.378168$   
 between the Head-lands

**PLAIN Scale**, is a thin Ruler, either of Wood or Brass, whereon are graduated the Lines of *Chords*, *Sines*, *Tangents*, *Secants*, *Leagues*, *Rhumbs*, &c. and is of ready Use in most part of the *Mathematicks*, chiefly in *Navigation*: A Description thereof see under the Word *Scale*.

**PLAIN Table**, is an Instrument used in Surveying of Land.

1. The *Table* it self is a Parallelogram of Wood, 14 Inches and a half long, and 11 Inches broad, or thereabouts.

2. A *Frame* of Wood fixed to it, so as a Sheet of Paper being laid on the *Table*, and the *Frame* being forced down upon it, squeezeth in all the Edges, and makes it lie firm and even, so as a

Plot may be conveniently drawn upon it. Upon one Side of this *Frame* should be equal Divisions for drawing Parallel Lines both long-wise and cross-wise (as Occasion may require) over your Paper; and on the other Side the 360 Degrees of a Circle, projected from a Brass Centre conveniently placed in the *Table*.

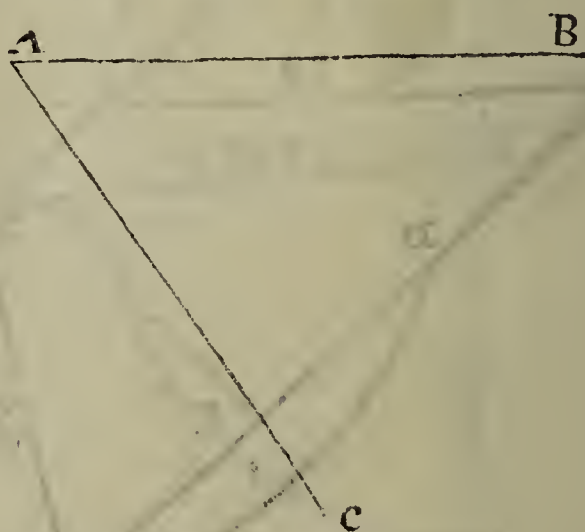
3. A *Box* with a *Needle* and *Card*, to be fixed with two Screws to the *Table*; very useful for placing the Instrument in the same Position upon every Remove.

4. A *Three-legged Staff* to support it, the Head being made so as to fill the Socket of the *Table*, yet so as the *Table* may be easily turned round upon it, when 'tis not fixed by the Screw.

5. An *Index*, which is a large Ruler of Wood, (or Brass,) at the least 16 Inches long, and two Inches broad, and so thick as to make it strong and firm; having a sloped Edge, called the *Fiducial Edge*, and two Sights of one Height, (whereof the one hath a Slit above, and a Thread below, and the other a Thread above, and a Slit below,) so set in the Ruler, as to be perfectly of the same Distance from the *Fiducial Edge*. Upon this *Index* 'tis usual to have many Scales of equal Parts, as also Diagonals, and Lines of Chords.

To take the Quantity of an Angle by the Plain Table.

As suppose  $AB$  and  $AC$  were two Hedges or Fences of a Field, and it were required to take the Angle  $A$ .



Plant your *Table* (fitted with the Sheet upon it) as nigh to the Angle as you can, the North End of the *Needle* hanging directly over the *Flower-de-Lis*; then make a mark upon the Sheet of Paper at any convenient Place for the Angle  $A$ , and lay the End of the *Index* to the Mark, turning it about 'till through the Sights you espy  $B$ ; then draw the Line  $AB$  by the Edge of the *Index*. Do the same for the Line  $AC$ , keeping the *Index* upon the first Mark: Then will you have upon your *Table* an Angle equal to the Angle in the Field.

When you have more Angles to take, the Method is the same.

The Distances from the Angles to the Instrument are measured by the *Chain*, and set off on the *Table* with a *Scale* and *Compasses*.



Whence 'tis so ealie to take the Plot of a Field at one *Station*, by the *Plain Table*, that there needs no other Direction. See *Surveying*.

**PLAIN** [in *Heraldry*] the Point of the Shield when couped; a Part remaining under the Square of a different Colour or Metal from the Shield.

**PLAINT** [in *Law*] is the Propounding or Exhibiting any Action real or personal in Writing.

**PLAINTIFF**, is he that sues or *complains* in an Assise, or in an Action Personal; as in an Action of Debt, Trespass, Deceit, Detinue, and the like.

**PLAN**, [in *Architecture*, &c.] is a Draught of a Building, as it appears, or is intended to appear on the Ground, shewing the Extent, Division and Distribution of the Area into its Apartments, Rooms, Passages, &c.

*Rais'd PLAN* [in *Architecture*] is that which shews the Elevation or upright upon the *Geometrical Plan*, so as to hide the Distribution.

*Geometrical PLAN* [in *Architecture*] is one in which the solid and vacant Parts are represented in their proper Proportion.

*Perspective PLAN* [in *Architecture*] is one that is conducted and exhibited by Degradations or Diminutions according to the Rules of Perspective.

**PLANCERE**, in Architecture, is the under part of the Roof of the *Corona*; which is the superior Part of the Cornice, between two *Cymatiums*. See those Words.

**PLANE**, is an Instrument used in *Joinery*, to make Boards plane, try, and smooth, or in order to joint or frame them together, &c. These are of several Names and Sorts according to the several Uses; as, 1. The *Fore-plane*, which is a long Plane, and used first of all before either *Smoothing-plane* or *Jointer*. The Edge of the Iron of this Plane is not ground streight, but rising with a Convex Arch in the middle of it, that its Edge may bear to be set the *Ranker*, for its Use is to take off the Irregularities of the Stuff as soon as may be, in order to prepare it for the *Smoothing-plane*, or *Jointer*. If the *Stuff* be free and frowy, that is, even tempered all over, you may then set the Plane so *rank* as that you may take off a Shaving of the Thickness of an old Shilling; but if it be hard or curling, you can't take off one thicker than an old Groat. 2. The *Smoothing-plane*, is a short small Plane, whose Iron is set very fine, and its use is to take off the Irregularities of the *Fore-plane*, or those which it hath left. 3. The *Jointer* is a Plane longer than the *Fore-plane*, and hath its *Sole* perfectly strait from End to End; it comes after the *Fore-plane* and *Smoothing-plane*, and is design'd to shoot an Edge of a Board perfectly streight in order to jointing, as also Boards of any Thickness; for 'tis used to *Try*, as they call it, that is, smooth Tables with, whether large or small; wherefore its Iron must be set very fine, little above an Hair's breadth above the Sole of the Plane, and the length of the Edge of it exactly strait, or parallel to the Plane of the Sole or Bottom of the Plane. 4. The *Strike-Block* is a Plane made as true as the *Jointer*, and like it, only shorter; being used to shoot a short Joint, which it doth more handily and readily than the long *Jointer*. 'Tis used also for framing and fitting the

Joints of *Mitres* and *Bevels*, but then the piece of Wood is drawn by Hand over the Plane several Times till 'tis shot true. 5. The *Rabbit Plane* is used to cut part of the upper Edge of a Board strait or square down into the Stuff, so that the Edge of another Board cut down after the same manner may fit and join in with it on the Square; and when two Boards are thus cut away, this lapping over is called *Rabbiting*. The *Rabbit-plane* is sometimes used also to strike a *Fascia*, in a piece of Moulding. The Iron of this Plane is full as broad as the Stock is thick (usually about an Inch) that the Angles of the Edge may cut down exactly strait; and it delivers its Shavings at the Side and not out of a Mouth at the Top, like other Planes. 6. The *Plow*, is a narrow *Rabbit-plane*, with the Addition of two Staves with Shoulders to them, and on the Bottom of the Shoulders a Fence: Its use is to plow a narrow square *Groove* on the Edge of any Board, of any proper Depth. 7. *Moulding-planes*, of which are several kinds, as the Round Plane, the Hollow, the O—G—, the Snipes Bill, &c. and these of several Sizes, as from half an Inch to an Inch and half. When these Planes are used on soft Wood, as Deal, Pear-Tree, Maple, &c. the Iron is set to an Angle of 45 Degr. with the Sole or Base of the Plane; but if it be very hard Wood, as Box, Ebony, Lignum Vitæ, &c. it is set to 80 Deg. and sometimes quite upright. There is also some difference in the grinding of the *Basil* or the Slope of the Edge of the Iron of the Plane; for in working on hard Wood this is ground to an Angle of about 18 or 20 Deg. but in soft Wood, not to one above 12 Degrees; for the more acute the *Basil* is, the better and smoother the Iron cuts, but the more obtuse and thicker it is, the stronger is the Edge to cut upon hard Work.

*PLANE of a Dyal*, is the Surface on which any Dyal is supposed to be described. See a General Account of all such *Planes* under the Word *Dyalling*.

*PLANE Horizontal*, in Perspective, is a Plane which is parallel to the Horizon, and which passes thro' the Eye, or hath the Eye supposed to be placed in it.

*PLANE of Gravitation or Gravity*, in any heavy Body, is a Plane supposed to pass thro' the Centre of Gravity of it.

*PLANE*, in Fortification, is the Representation of a Work in its Height and Breadth.

*PLANE of the Horopter*, in Opticks, is that which passeth thro' the *Horopter*, and is perpendicular to the Plane of the two *Optical Axes*.

*PLANE Number*, is that which may be produced by the Multiplication of two Numbers one into another; thus, 6 is a *Plane Number*, because it may be produced by the Multiplication of 3 by 2; for twice 3 makes 6. So also 15 is a *Plane Number*, arising from 5 being multiplied by 3: And 9 is a *Plane Number*, produced by the Multiplication of 3 by 3.

*PLANE Problem*, in Mathematicks, is such an one as cannot be solved Geometrically, but by the Intersection either of a Right Line and a Circle; or of the Circumferences of two Circles: As, *Having the greatest Side given, and the Sum of the other Two, of a Right-angled Triangle; to find the Triangle. To describe a Trapezium that shall make a Given Area of Four Given Lines.* And such a



*Problem* can have but two Solutions, because a Right Line can cut a Circle, or one Circle another but into Points. *Ozanam.*

**PLANE Geometrical**, in Perspective, is a Plane Surface, parallel to the Horizon, placed lower than the Eye; wherein the visible Objects are imagined without any Alteration, except that they are sometimes reduced from a greater to a lesser Size.

**PLANE of the Projection**, in the Astronomical Perspective, or Stereographick Projection, is a Plane which passeth thro' the Centre of the Sphere, the being supposed the Pole of or in a Point in the Axis of that Plane, and 90 Degr. above it or the Surface of the Sphere; thus, if the Eye be in the Zenith or Nadir Points, the Horizon will be a Plane on which the Circles of the Sphere may be projected Stereographically: And from hence it will follow, that all great Circles of the Sphere, passing thro' the Eye-point, must be at Right Angles to the Plane of the Projection, because they pass thro' its Poles. See *Spherick Geometry*, or *Projection* in Vol. I.

**PLANE of Reflection**, in Catoptricks, is that which passeth thro' the Point of *Reflection*, and is always perpendicular to the Plane of the Glass, or Reflecting Body.

**PLANE of Refraction**, is a Surface drawn thro' the Incident and Refracted Ray.

**PLANE Surface**, is that which lies even between its bounding Lines; and as a Right Line is the shortest Extension from one Point to another, so a *Plane Surface* is the shortest Extension from one Line to another.

**PLANE Vertical**, in Opticks and Perspective, is a Plane Surface which passeth along the Principal Ray, and consequently thro' the Eye, and is perpendicular to the Geometrical Plane.

**PLANETS**, are the *Erratick* or *Wandering Stars*, and which are not like the *Fixed ones* always in the same Position to one another. We now Number the Earth among the *Primary Planets*, because we know it moves round the Sun, as *Saturn*, *Jupiter*, *Mars*, *Venus*, and *Mercury* do, and that in a Path or Circle between *Mars* and *Venus*. And the *Moon* is accounted among the *Secondary Planets*, or *Satellites* of the *Primary*, since she moves round the Earth, as *Jupiter's* Four *Moons* or *Satellites* do round him, and *Saturn's* Five round about him; if *Cassini's* Eyes may be credited. But I could never see my self, or meet with any else, who ever did see any but the *Hugenian Satellite*.

All the Planets, as far as we can find, have, besides their Motion round the Sun, which makes their Year, also a Motion round their own Axes, which makes their Day; as the Earth's revolving so, makes our Day and Night.

It's more than probable that the Diameters of all the Planets are longer than their Axes: We know 'tis so in our Earth; and Mr. *Flamsteed* and Mr. *Cassini* both found it to be so in *Jupiter*. And therefore 'twas a great Mistake in the Ingenious Dr. *Burnet*, to assert, as he doth in his *Hypothesis*, the Polar Diameter of the Earth to exceed the other.

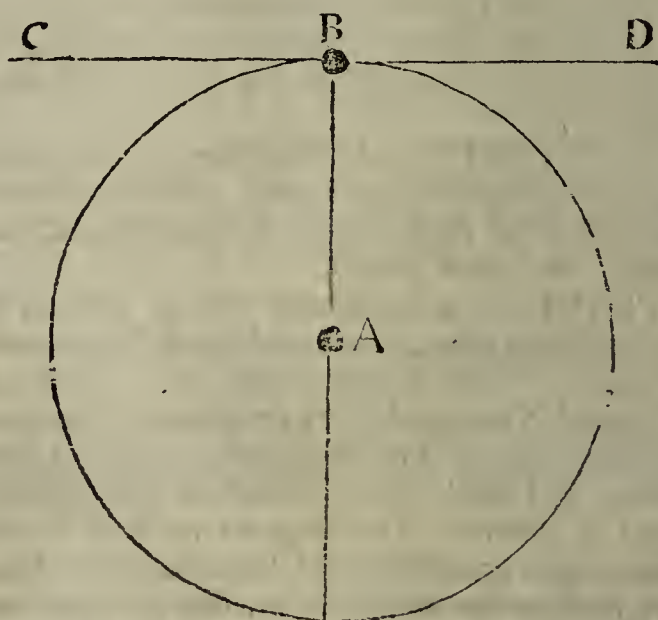
Sir *Isaac Newton*, asserts our Earth's Equatorial Diameter to exceed the other by about 34 Miles: And indeed else the Motion of the Earth would make the Sea rise so high at the Equator, as to drown all the Parts thereof.

The Learned Mr. Whiston, Professor of Mathematics in the University of Cambridge, in his *New Theory of the Earth*, accounts (from the Admirable Sir Isaac Newton's *Principles*) for the Motion and Revolution of the Planets, thus:

### LEMMA X.

From the uniform Projectile Motion of Bodies in Straight Lines, and the universal Power of Attraction or Gravitation, the Curvilinear Motion of all the Heavenly Bodies does arise.

If a Body, as B, be moving uniformly along the Line DC, from D to C, and another Body A be present, this latter Body A must draw the former B from its Straight Line DC: And by doing so continually, while at the same time the Body B retains its Projectile Force along a Straight Line in every Point of its Course, must make the Line of its real Motion become a Bent one, and change its Rectilinear into a Curvilinear Trajectory.



Hence may be learnt what is that *Conatus recedendi a centro motus* in revolving Bodies, and in what Sense 'tis to be understood. For since all Bodies have a *Vis centripeta* or Propension towards one another, 'tis impossible they should of themselves, in as proper a Manner, have a contrary Propension, or *Vis centrifuga*, an Endeavour of avoiding one another. The true meaning therefore of this *Attempt* or *Endeavour* to get farther off the Centre of Motion is only this, That all Bodies being purely passive, and so incapable of altering their uniform Motion along those Straight Lines or Tangents, to their Curves, in which they are every Moment, do still tend onwards in the same Lines, and retain their Propension or Effort towards that Rectilinear Motion all the Time they are obliged to move in Curves; and consequently at every Point of their Course, endeavour to fly off by their Tangents. Now the Parts of the Tangent, to which this Endeavour is, being farther from the Centre than those of the Curves to which the Bodies are actually forced, an Attempt to go on in the Tangent may be, and is styled an Attempt to go farther off, or recede from that Centre; tho' from no other Affection than that of Inactivity, or of persevering in a Rectilinear Motion: So that tho' the *Vis centripeta*, or Power of Gravitation, be an Active and Positive Force, continually



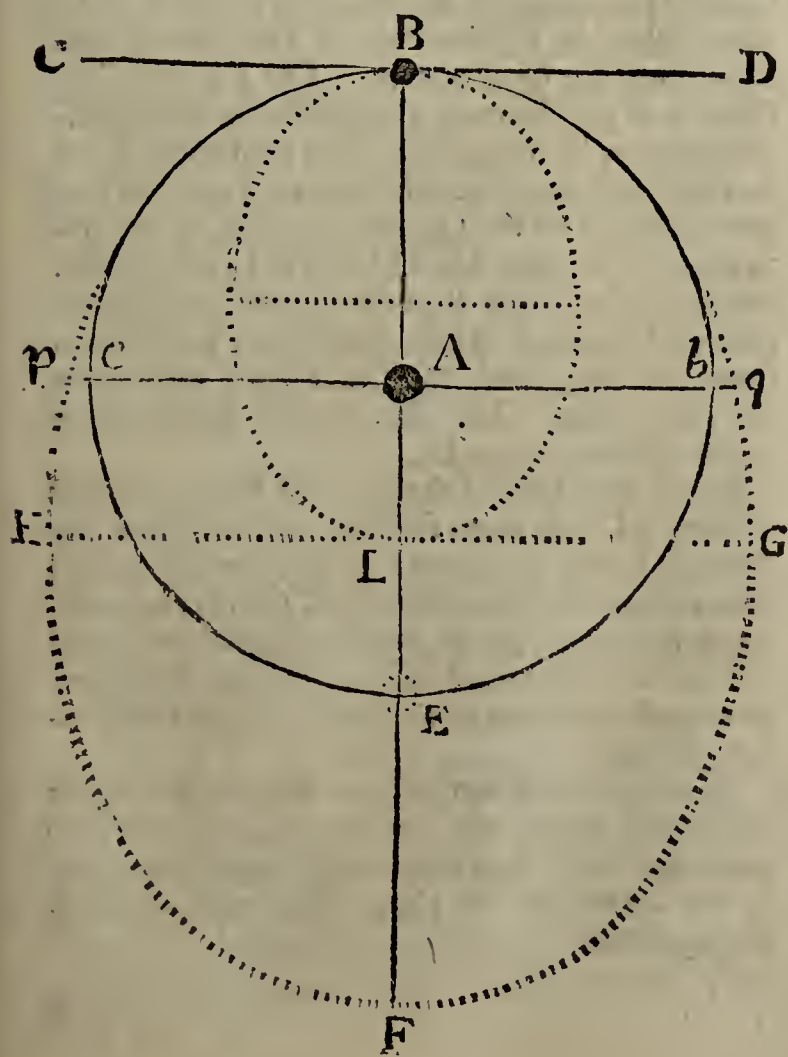
tinually renew'd and impress'd on Bodies; yet the *Vis Centrifuga*, or *Conatus recedendi a centro motus*, is not so, but the meer Consequence and Result of their Inactivity.

This is evident in Bodies revolving in *Ellipses* about one of the *Foci*, in their Descent towards it; where the Tangent being oblique to the Radius, or Line from the Point of Contact to the *Focus*, this very *Conatus recedendi a centro motus* carrying it along the Tangent, will for some time make it approach nearer to the *Focus*; tho' not near so much as by its revolving in the *Ellipsis* it self.

For let a Stone be let loose from the Sling, or any Revolving Body be disengaged from the Force which retained it in its Curve, and it will not go from the Centre, but only pass along the Tangent in which it was moving, as if there were no such Centre near it at all.

When the Projectile Motion of the *Planets* is in its Direction perpendicular to a Line from the Sun, and in its Degree of Velocity, so nicely adapted and temper'd to the Quantity of the Sun's Attraction there, that neither can overcome the other, (the Force of Gravitation towards the Sun, and the Celerity of the Planets proper Motions, being perfectly in *equilibrio*,) the Orbits of such Revolving Planets will be compleat Circles; themselves neither approaching to, nor receding from the Sun, the Centre of their Motions. And the Case is the same in the Secondary Planets about their Primary ones.

Thus 'tis supposable, That the Velocity of all the Planets about the Sun, was exactly accommodated originally to his Power of Attraction; and that their Primitive Orbits were perfect Circles; from which at this Day they do not much differ. Thus, however, *Jupiter's* Four Satellites or little Moons have their Motions so exactly proportioned to their Gravitation to him, that their Orbits, as far as the most nice Observations can judge, are perfect Circles, they keeping at an equal Distance from his Centre in all the Points of their Courses about him.



When the Projectile Motion is not adapted to, but is either too swift or too slow for the Attraction towards the Central Body, the Orbits described will be *Ellipses*; and in the former Case, when the Projectile Motion is too swift, the Orbit will be bigger than the Circle; and the nearer *Focus* of the *Ellipsis* will be coincident with the Central Body.

And in the latter Case, the Orbit will be less than the Circle, and the farther *Focus* of the *Ellipsis* will be coincident with that Central Body. Thus if the Celerity of B be exactly correspondent to the Attractive Force of the Central Body A, neither will prevail; and the Body preserving an equal Distance from the Centre, will describe the Circle B E b.

If the Celerity be greater, it will overcome the Attraction, and cast it self farther off the Centre for some time, and so revolve about it in the larger *Ellipsis* B H F G; the Central Body possessing that *Focus* A which is nearest the Point B, where the Attraction began. But if the Celerity be smaller, the Attraction of the Central Body A will be too hard for it, will force it for some time to come nearer, and to describe the lesser *Ellipsis* B K L I; the Central Body possessing that *Focus* A which is farthest from the Point B, where the Attraction began: As will be very plain from the Consideration of the Figure relating hereto.

'Tis indeed possible that the Celerity of Bodies may be so great, compared with the Force of Attraction to the Central Body, as to cast them off with such Violence, that the Attraction will never be able to bring them round, or make them revolve about it: In which Case the Orbits described will be one of the other Conick Sections, either *Parabolas* or *Hyperbolas*, according to the less or greater Violence with which the Bodies are thrown; and the Central Body will possess the *Focus* of such a Figure. But no *Phænomena* of Nature persuading us that *de facto* any of the Heavenly Bodies do describe either of those Lines, (tho' Comets *Ellipses* come near to *Parabolas*;) several Bodies moving about the same Central one, tho' their Primitive Velocity were equal, and Direction alike, yet if they be at different Distances from it, they will describe Figures of different Species about it. For when that determinate Degree of Velocity, which at one Distance were just commensurate to the Central Body's Attraction, and so would produce a Circular Orbit, must at a farther Distance be too hard for it, by reason of the Diminution of the Attraction there; an *Elliptical* Orbit must be described, whose nearer *Focus* would be coincident with the Central Body. In like manner, when the same determinate Degree of Velocity were at a nearer Distance, where the Central Attraction is augmented, it would be too little for the same; and an *Elliptical* Orbit must be described, whose farthest *Focus* would be coincident with the Central Body. This cannot be difficult, if you consider that the Species of the Planetary Orbits depends solely on the Proportion between the Attraction towards the Central Body, and the Velocity of the Projectile Motion; as that Proportion remaining at any Distance whatsoever, the Bigness of the Orbits will be various, but the *Species* the same: So when that Proportion is changed, the *Species* of the Figures



gures must be changed also; which being done, the Velocity given, by the various Force of Attraction in several Distances from the Centre, as well as by the various Velocities at a given Distance, of which before; 'tis evident the *Species* of the Orbits will be different in this as well as in the former Case.

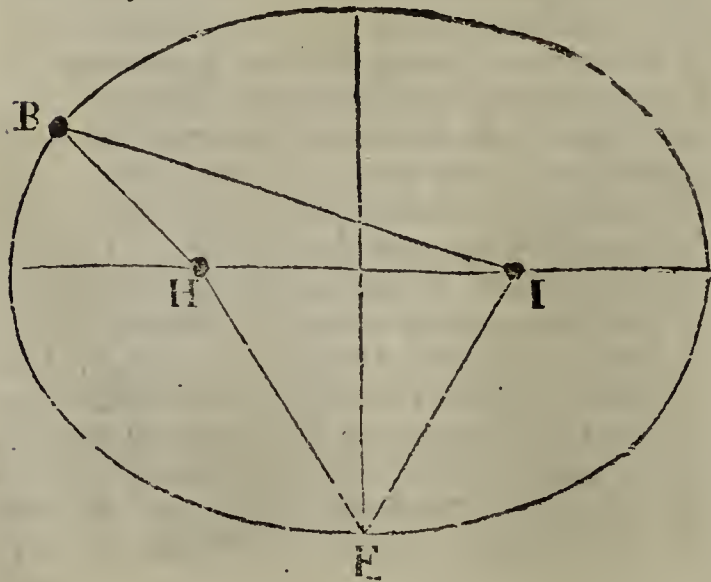
And the greater Disproportion there is between the Quantity of Attraction and the Velocity of the Revolving Bodies; the farther from a Circular, and the more Oblong and Eccentric will the Orbits described be. And the greater Approach to Correspondence there is, the nearer to Circular, and the less Oblong and Eccentric will the same Orbits be.

The Circular Orbits of Planets depend not only on the exact Adjustment of the Projectile Velocity to the Attractive Power of the Sun, but upon the Direction of the same Projectile Motion, at the Original Commencing of the Attraction.

Thus where the Planet is in its own Tangent, neither Ascending nor Descending, and the preceding Angle CBA is a Right one, which we have hitherto supposed; from the Correspondence of the Velocity to the Attraction, the Orbits will be perfect Circles. Otherwise, when the Direction of the Motion is Oblique, in any Measure ascending from or descending to the Central Body, and the preceding Angle CBA Obtuse or Acute; the Planet, tho' its Velocity were exactly adapted to the Attraction of the Central Body, would revolve in an *Ellipsis*; and the Point B, where the Attraction began, would be the End of the lesser Axis thereof.

If a Planet describe an *Ellipsis* about its Central Body in the *Focus* thereof, it will move fastest when 'tis nearest to, and slowest when 'tis farthest from the said Central Body or *Focus*, and agreeably in the intermediate Places. For seeing wheresoever the Revolving Body is, the Area is still proportionable to the Time, and so in equal Times always equal; 'tis evident by how much the Distance is less, and the Line from the *Focus* is shorter, by so much must the Bodies Motion be swifter to compensate the same; and *vice versa*, by how much the former is longer, by so much must the latter be slower to allow for it.

If the Planet B describe an *Ellipsis* about the Central Body in the *Focus* H, as the Area described by the Line BH, will be exactly Uniform and Proportional to the Time of Description; so the Angular Motion, or Velocity of the Line from the other *Focus* BI, will be Proportional to the Time, and Uniform also, tho' not so Exactly and Geometrically.



The Law of Gravitation being supposed, if one Planet describe an *Ellipsis* about the Central Body in the *Focus* H, and another describe a Circle about the same in its Centre: If the Semi-diameter of the Circle be equal to HE, the middle Distance in the *Ellipsis* from the same Centre or *Focus*, their Periodical Times of Revolving will be the same; and when the Distances are equal, their Velocity will be so too.

Therefore, tho' the Planets revolve in *Ellipses* of several *Species*, yet their Periodical Times may be as well compared with one another, and with their Distances from the Central Bodies, as if they all revolved in Compleat Circles.

**PLANETS.** The Motions of the six Primary Planets round the Sun is so adjusted, that the Square of the Times of their periodical Revolutions are as the Cubes of their Distances from the Sun: And the same thing is found by all Astronomers to be true, with Regard to the Motions of the *Secondary Planets* or *Satellites* round their primary ones. *Greg. Astron. p. 26, 27.*

The Forces with which the *Primary Planets* are continually drawn from a Rectilineal Motion, and by that Means are retained in their Orbits, are reciprocally as the Squares of their Distances from the Centre of the Sun. *Id. p. 33.*

The Forces with which the *Secondary Planets* are retained in their Orbits, are reciprocally as the Squares of their Distances from the Centres of their Primary Planets about whom they revolve. *p. 34.*

The *Nodes* and *Apsides* of all the Planetary Orbits are at rest and do not move progressively. *p. 55.*

The Planets and Comets are retained in their Orbits by the Force of Gravity; the same Law prevailing thro' all the Solar System. *p. 57.*

If a Primary Planet revolving round the Sun as its Centre carry round with him a Satellite which revolves also round the Planet; the Motion of this Satellite will be *accelerated* all the while it is moving from the Quadratures to the Syzygies, and *retarded* all the while it is moving from the Syzygies to the Quadratures: So that it will move *faster* near either its Conjunction or Opposition, and *slower* near the Quadratures. The Figure of its Orbit will also be more *Curvilinear* in the Quadratures than in the Syzygies, and consequently the Satellite will be or recede farther from the Primary Planet, in the Quadratures than in the Syzygies, so as that the Orbit will be an *Ellipsis*, whose Centre is the Primary Planet, and whose greater Axis lies at Right Angles to a Line drawn from the Sun; and the lesser Axis coincident with that Line. This Dr. Gregory demonstrates in his *Astron. p. 282, &c.*

But if the Orbit of the Satellite Planet, instead of being a Circle be an *Ellipsis*, in whose *Focus* the Primary Planet is supposed to be placed, then will the greater Axis of this Elliptical Orbit, twice advance forward, *viz.* in the two Quadratures, and twice recede backward, *viz.* in the two Syzygies, of every Revolution of the Satellite round the Planet. *p. 298.*

In each Revolution of the Satellite round the Planet the *Apsides* will, for the most part, advance more forwards than they recede backwards, and by the Excess of this Progression, will move in *Consequentia*.



If we consider the Figures of the Planets, we shall find that they have such Figures, which follow from these very Laws by which the System is govern'd; which is very agreeable to that admirable Order which we observe every where, that no Forces act upon the Planets to destroy them; that is, that the Figure of a Planet, whether it be a Primary or Secondary Planet, is such as it would acquire, if it wholly consisted of fluid Matter; which agrees with the *Phænomena*.

Whence it follows, that all the Primary and Secondary Planets are Spherical; for they consist of a Matter, whose Particles gravitate towards one another, from which mutual Attraction a Spherical Figure is generated in the same Manner as a Drop becomes round from another Sort of Attraction of the Parts.

This Spherical Figure of the Planets is not chang'd from their Motion round the Sun, or from the Motion of the Secondary Planets about their Primary ones; because all the Particles are carried by the same Motion: But this Figure undergoes some Change by the Motion round the Axis, and so much the greater as this Motion is swifter.

Let  $PP$  be the Axis of a Planet (See the Fig.)  $Ee$  the Diameter of the Equator, perpendicular to the Axis; let there be a Canal  $PCE$  fill'd with a Liquid; this Fluid will descend by its Gravity in both Legs towards  $C$ , and will not be at rest till the Pressure in both Legs be equal, if the Planet be at rest, the Height of the Fluid in both Legs will be equal; but if the Planet be moved about its Axis  $Pp$ , all the Liquid in the Leg  $CE$  will endeavour to recede from the Center by its centrifugal Force, which Force acts contrary to Gravity, and therefore diminishes the Gravity; so that there is no *Equilibrium* till  $CE$  exceeds  $CP$ . Now if the Canal be taken away, the lateral Pressure of the Fluid, of which the Planet consists, does not change the Gravity towards  $C$ , nor the Difference between the Heights of the Columns  $CE$ ,  $CP$ ; therefore the Planet is every where higher in the *Æquator* than in the Poles, and acquires by its Motion round its Axis, the Figure of a Spheroid depress'd in its Poles; for the Elevation is continually diminish'd as you go towards the Pole, because the centrifugal Force is diminish'd by Reason of the Diminution of the Distance from the Axis.

If what has been demonstrated be compared with the *Phænomena*, it will appear why all the Bodies in our System are Spherical; but that this Figure is not exact, but a little chang'd by their Motion round their Axis; tho' this cannot be observed in most of them, may be deduced from Observations made upon *Jupiter* and the *Earth*; Astronomers have observ'd that the Axis of *Jupiter* is shorter than its *Æquatorial* Diameter; altho' this Planet be the greatest of all the Planets, it is moved the swiftest about its Axis, and therefore this Difference may be observed.

The Elevation of the *Earth* at the Equator is determin'd by us, altho' perhaps to the Inhabitants of the other Planets, if there are any, it may not be more sensible than the Elevations on *Mars* and *Venus* are to us, which are so small that we cannot perceive them.

Suppose the *Earth* to be fluid, it will acquire the aforesaid Spheroidal Figure; if the Parts

cohere towards the Center, the Position of the other Parts will not be chang'd thereby, nor will it be changed if in some Places the Parts cohere together quite to the Surface; so that the Surface of the Sea must necessarily acquire a Spheroidal Figure depress'd at the Poles, but since the Shores are every where but a little elevated above the Surface of the Sea, it is certain that the Continent acquires the same Figure.

Now to measure this Elevation, that is, how much the Diameter of the *Æquator* of the *Earth* is longer than the Axis, we must consider its Motion round its Axis in the Space of 23 Hours, 56 Min. 4 Sec. And supposing the *Earth* Homogeneous, the Computation will be made in the following Manner.

The Periphery of the *Earth* is 128202185 Rhyndland Feet; therefore in one Second of Time, a Point of the Equator goes thro' 1488 Feet; the versed Sine of which Arch 0,054, a Space which could be gone by a Body in such a Time by the centrifugal Force.

By Gravity, a Body, in one Second, as we have shewn before, falls thro' 15.607 Rhyndland Feet; but these Experiments were made at the Distance of 48 Degrees from the Equator  $Ee$ , (See the Figure) at the Point  $A$ , the centrifugal Force at  $E$  is to the centrifugal Force at  $A$ , as  $CE$  to  $CA$ , for these Lines are very little different at  $AB$ ; let this centrifugal Force be  $Ab$ , having drawn the Perpendicular  $ba$  to  $CA$  continued, let the Force thro'  $Ab$  be resolved into two other Forces directed along  $Aa$  and  $ab$ ; the Gravity is diminished only by the former, and  $Ab$  is to the Force diminishing it, as  $CA$  to  $AB$ , by Reason of the similar Rectangular Triangles  $Ab a$  and  $ABC$ , which have their opposite vertical Angles equal at  $A$ ; therefore the centrifugal Force at the Equator, with which a Body in one Second goes thro' 0.054; is to the Force which diminishes the Gravity at  $A$ , in a duplicate Proportion of the Radius  $AC$  to  $AB$ , which is the Co-Sine of the Latitude  $AE$  of 48 Degrees, so that from this diminishing Force the Body in one Second goes through, 0,0243; wherefore, if the *Earth* was at rest, in falling it would not go thro' 15.607 Feet, but 15.632; with which Gravity a Body falls under the Poles, because the Points are not mov'd at the Equator, by the centrifugal Force, a Body goes thro' 0.054, and falls as much in the same Time from the Height of 15.578 Feet; whence it appears that the Gravity under the Poles, is to the Gravity under the Equator, as 289 to 288.

If the Figure represents the Figure of the *Earth*, the Weight of a Column of Liquid  $CE$  will be to the Weight of a Column of Liquid  $CA$ , the *Earth* being at rest, as 288 to 289; for otherwise, the *Earth* moving, there will not be an *Equilibrium*; because  $\frac{1}{288}$  of the Column  $CE$  is sustain'd by the centrifugal Force; for the centrifugal Force decreases as you come towards the Center in the Ratio of the Distance, in which Ratio also the Gravity decreases, so that in all the Points of the Column the same Part of the Weight is sustain'd as towards the Surface.

Whence we deduce, that the Height  $CP$  at the Pole, is to the Height  $CE$  at the Equator, as 229 to 230; for supposing this Ratio between the Axis and the Equatorial Diameter, if a Com-



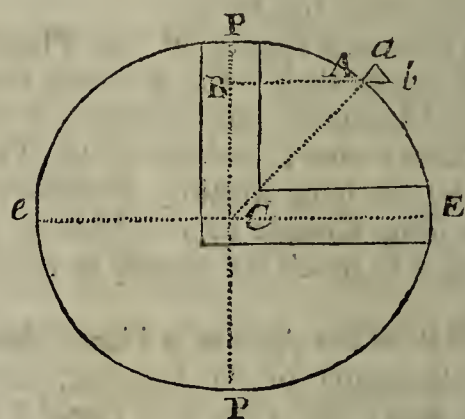
putation be made of the Gravities in the Places P and E, the Earth being at rest, they are found to be to one another as 1121.71 to 1120.71, which Ratio obtains every where in correspondent Points, that is, which are distant from the Center as C P to P E; because in both Legs the Gravity decreases in proportion to the Distance from the Center. You have the Weight by multiplying the Quantity of Matter by the Gravity; for the Weight encreases in a Ratio of both; by multiplying 1121.71 by 229, and 1120.71, by 230, the Products are to one another as 288 to 289; which is the Ratio of the Weights before discovered. The mean Diameter of the Earth is 3400669 Perches, therefore the Axis P P is 3393261, and the Equatorial Diameter E e is 3408078 Perches, which exceeds the Axis by 14817 Perches, (*viz.*)  $\frac{1}{230}$ , and the Equator is more elevated by 7408.5.

In this Computation, as we have said, we have look'd upon the Earth as Homogeneous; but if it be more dense towards the Center, the Matter which is added to it may be look'd upon as a separate Body, from whose Centre the Points P and E are unequally distant, and towards which therefore the Bodies P and E have a different Gravity; and the Difference is so much the greater as these Differences are greater; and it will be also so much the greater in respect of the whole Gravity, as the Quantity of Matter which is added, or which is the same, as the Density is greater towards the Center, is greater.

It is plain that the Forces of Gravity at the Poles and the Equator differ from one another more than  $\frac{1}{230}$  Part, by comparing together Experiments made at several Distances from the Equator, by the help of Pendulums, by which the Forces of Gravity may be compared together, as we have shewn; and which difference is truly nearly double that which is found by Computation; whence it follows, that the Elevation of the Equator is nearly double that which we have determined to be 7408.5 Perches.

Now if we consider the spheroidical Figure of the Earth, we shall see that heavy Bodies don't tend directly to the Earth's Center, unless at the Poles and the Equator, but every where perpendicularly to the Surface of the Spheroid; for a Liquid will not be at rest unless its upper Surface forms a right Angle with the Direction of heavy Bodies, and the Figure of a Spheroid is form'd by the Surface of a quiescent Fluid, we also deduce this Direction of heavy Bodies from the centrifugal Forces. The Body A, by its Gravity, tends towards C, and is carried by its centrifugal Force along A b; this Force at the Point A is to the Gravity along A C, as 1 to 430.8, having form'd a Parallelogram with the Sides A c and A b, supposing these to one another as 430.8 to 1, the Diagonal will shew the Direction of heavy Bodies, forming a small Angle with the Line A C. The Force along A b encreases as you go towards the Equator, whereby this Angle is encreas'd, but is diminished by the Encrease of the Angle C A b; so that in the Equator, where the centrifugal Force is greatest, the Direction of heavy Bodies coincides with P C; because there is no centrifugal Force there. In this spheroidical Figure, the Latitude of the Place is determin'd by an Angle as A C E, which is made with the Equator, by

a Line drawn from the Place to the Center, dividing this whole Arch P A E, by this Method, into 90 Parts, that is, into Degrees, it will easily appear, that going towards the Poles, the Degrees are encreas'd on the Surface; but this Difference is so very small that in measuring Degrees that are not very distant, it cannot be discover'd; because the Error arising from the Make and Use of the Instruments, exceeds this Difference, whence Degrees measur'd at the South and North of France, as also in England, differ little from one another, and the middle one is the least of all; wherefore nothing can be concluded concerning the Earth's Figure from these Measures.



PLANETARY, or pertaining or relating to the Planets.

PLANETARY System, [in *Astronomy*] is a System or Assemblage of the Planets, both Primary and Secondary, moving in their respective Orbits, round their common Centre.

PLANIMETRY, [of *planus*, plain, and *μετρέω*, Gr. to measure] the same with *Planometria*; which see.

PLANISPHERE, [of *planus* and *σφαῖρα*, Gr.] signifies the Circles of the Sphere described in *Plano*, or on a Plane; or it is a Plane or Flat Projection of the Sphere. And thus the Maps either of Heaven or Earth are called *Planispheres*, as also all other Astrolabical Instruments. And all Charts or Maps for the Use of Mariners, are called by Mr. Wright the *Nautical Planisphere*. See *Nautical*.

PLANO Concave Glass is a *Lens*, one of the Surfaces of which is Concave, and the other Plain.

PLANO Convex Glass is a *Lens*, one of the Surfaces of which is Convex and the other Plain.

PLANOMETRIA, is the Mensuration of all Plane Surfaces or Figures.

PLANTARIS, is a Muscle of the *Tarsus*, so called from its Tendon expanded in the

PLANTA *Pedis*, like that of *Palmaris* in the Palm of the Hand. It arises Flethy from the Back-part of the outermost Tubercle of the lower Appendage of the Thigh-Bone, immediately under the External Beginning of the *Gastrocnemius Externus*; and descending obliquely between it and the *Gastrocnemius Internus*, soon becomes a thin flat Tendon; and which passing out from between their Flethy Bellies, descends internally laterally, by their great Tendon; and marching over the *Os Calcis*, expands it self on the Soal of the Foot, which it firmly adheres to, and to the Flethy Body of the *Musculus flexor digitorum perforatus*, and is inserted on both Sides the first Internode of each Lesser Toe. The Action of this Muscle is very obscure.



## P L A N T S.

The Learned and Experienced Botanist, Mr. John Ray, gives us the following Characteristick Notes of the chief Kinds of Plants; which make Twenty five Genders.

1. The Imperfect Plants, which do either totally want both Flower and Seed, or else seem to do so; there having yet no Seed or Flower been discovered to belong to them, or at least but to few of them; such as Corals, Spunges, *Algæ Conserveæ*, Duck-meat, or the *Lens palustris*, the Fungi, *Tubera Terræ*, the Mosses, and some Liverworts.

2. Plants producing either no Flower at all, or an Imperfect one, and whose Seed is so small as not to be discernable by the naked Eye: Some of these bear their Seeds on the Back-part of their Leaves; as the Maiden-hairs, Spleen-worts, *Polypodium* and Ferns: Others bear it on the Stalk it self, adhering there by small single Foot-stalks; as the *Lichen Terrestris*, the *Lucopodium*, or Wolfsclaw, the *Adiantum Aureum*, the *Lunaria*, *Equisetum*, &c.

3. Those whose Seeds are not so small as singly to be Invisible, but yet have an Imperfect or Stameneous Flower, *i. e.* such an one as is without the *Petala*, having only the *Stamina* and the *Perianthium*; as Hops, Hemp, *Mercurialis*, Nettles, Docks, Sorrels, Arsefmart, Knot-grass, Pondweed, Orach, Blite, Beet, Ladies Mantle, &c.

4. Such as have a Compound Flower, and emit a kind of White Juice or Milk, when their Stalks are cut, or their Branches broken off; such as Lettuce, Sow-thistle, Hawkweed, Dandelion, Succory, Goats-beard, Nipplewort, &c.

5. Such as have a Compound Flower of a Discous Figure, the Seed *Pappose*, or winged with Down, but emit no Milk as the former do; as Colts-foot, Fleabane, Golden Rod, Ragweed, Groundsel, Cudweed, &c.

6. The *Herbæ Capitatæ*, or such whose Flower is composed of many small long Fistulose or hollow Flowers gathered together in a round Button, Ball, or Head, which is usually covered with a Squammose or Scaly Coat, of which Kind are the Thistle, the greater Burdock, Blue-Bottle, Knapweed, Saw-worth, &c.

These have all a Down adhering to their Seeds.

7. The *Corymbiferous Plants*, which have a compound discous Flower, but their Seeds have no Down adhering to them: The Reason of the Name you have under the Word *Corymbus*; of this kind, is Corn Marigold, Common Ox-Eye, Yarrow, the Daisie, Camomile, Tansie, Mugwort, Scabious, Teasel, Eryngo's, &c.

8. Plants with a perfect Flower, and having only one single Seed belonging to each single Flower; such as Valerian, Corn-sallet, Agrimony, Burnet, Meadow Rue, Fumitory, &c.

9. The *Umbelliferous Plants*, which have a *Pentapetalous Flower*, (*i. e.* one having just 5 small *Petala* or Leaves,) and belonging to each single Flower there are two Seeds lying naked and joined together. They are called *Umbelliferous*, because the Plant, with its Branches and Flowers, hath an Head like a Ladies Umbrella, which they call *Umbella*.

This is a very large Genus of Plants, which therefore he thus subdivides into,

1. Such as have a broad flat Seed, almost of the Figure of a Leaf, or which are encompassed round about with something like Leaves; as Cow-Parfney, Wild and Garden Parfney, Hogs Fennel, (*Pucedanum*,) &c.

2. Such as have a longish Seed swelling out in the middle, and larger than the former; as Shepherds Needle, Cow-weed, Wild Chervil, Common Speignel or Meu, &c.

3. Such as have a shorter Seed; as Angelica and Alexanders.

4. Such as have a Tuberous Root, as the Earth-Nut, Knipper Nut, or Pig Nut, Water Dropwort, and Hemlock Dropwort.

5. Such as have a small wrinkled channelled, or striated Seed; as Stone Parsley, Water Parsney, Burnet, Saxifrage, Caraways, Smallage, Hemlock, Meadow Saxifrage, Sampire, Fennel, Rock Parsley, &c.

6. Such as have rough, hairy, or bristly Seed; as Mountain Stone Parsley, Wild Carrot, or Birdnest, Hedge and Bastard Parsley, Hemlock, Chervil, Sea-Parsney.

7. Such as have their Leaves entire and undivided into Jags, &c. as *Perfoliata*, or Thorow-wax, Sanicle, the least Hares Ear, &c.

10. The *Stellate Plants*, which are so called, because their Leaves grow on their Stalks, at certain Intervals or Distances, in the form of a Radiant Star. Their Flowers are really *Monopetalous*, but divided into four Segments, which look like so many distinct *Petala*, or four Leaves; and each Flower is succeeded by two Seeds which grow at the bottom of it.

Of this Kind is Cross-wort, or Mugweed, with Maddar, Ladies Bedstraw, Woodruff, Cleavers, &c.

11. The *Asperifoliae*, or Rough-leav'd Plants. They have their Leaves placed alternately, or in no certain Order on their Stalks; they have a Monopetalous Flower cut or divided into five Partitions; and after every Flower there succeed usually four Seeds; such as Cynoglossa, or Hounds Tongue, Wild Bugloss, Vipers Bugloss, Comfrey, Mouse Ear, Scorpion Grass, &c.

12. The *Suffrutices* or *Verticillate Plants*: Mr. Ray, in his last Edition of his *Synopsis Methodica Stirp. Britann.* saith, The more certain Marks



or Characteristick Notes of this kind of Plants are, That their Leaves grow by Pairs on their Stalks, one Leaf right against another, their Flower is Monopetalous, and usually in the form of an Helmet or Hood, there succeed four Seeds usually to each Flower, and which have no other *Seed Vessel* but the *Perianthium*: For that Mark of their Flowers growing in Whirls about the Stalk, as they do in the Dead Nettle, Hore Hound, &c. is not found in all Plants of this Genus. To this Head belong Mother of Thyme, Mint, Penny-Royal, Vervain, Wood Betony, Self-heal, Alehoof, Bugle, *Scordium*, Motherwort, &c.

13. Such as have many naked Seeds (at least more than four) succeeding their Flower, which therefore they call *Polypermæ Plantæ Semine nudo*. By *naked Seeds*, they mean such as are not included in any Seed Pod, or Case, out of which they spontaneously drop; but such as either have nothing at all covering their Seeds, or else drop off with their Covering upon them. Of this Kind are Pilewort, Crowfoot, Marsh-Mallows, Avens, Strawberries, Cinquefoil, Tormentil, Meadow-sweet, &c.

14. *Bacciferous Plants*, or such as bear Berries; as Briony, Dwarf Honyfuckle, Butchers-broom, *Solomon's Seal*, Lilly of the Valley, Nightshade, Asparagus, Whorts or Whortle-berries, &c.

15. *Multifiliquous*, or *Corniculate Plants*; or such as have after each Flower many distinct, long, slender, and many times crooked Cases, or *Siliquæ*, in which their Seed is contained; and which, when they are ripe, open of themselves, and let the Seeds drop out: Of this kind is the Common Houfleeck, Orpine, Navelwort, or Walpennywort, Bearsfoot, Marsh Marigold, Columbines, &c.

16. Such as have a Monopetalous Flower, either Uniform or Difform, and after each Flower a peculiar Vessel, or Seed Case, (besides the common Calix) containing the Seed, and this often divided or parted into many distinct Cells. These by some are called *Vasculiferous Plants*, such as common Henbane, Marsh Gentian, Bindweed, Throatwort, Rampions, Toad Flax, Fox Glove, Yellow and Red Rattle, or Cock's-comb, Eyebright.

17. Such as have an uniform Tetrapetalous Flower, but bear their Seeds in Oblong Siliquous Cases; as your Stock-gilliflower, Wall-flower, common Whitloe Grass, *Jack* by the Hedge, or Sauce alone, common Mustard, Charlock or Wild Mustard, Radish, Wild Rocket, Ladies Smock, Scurvy-grass, Woad, &c.

18. *Vasculiferous Plants*, with a seemingly Tetrapetalous Flower, but of an Anomalous or Uncertain Kind: For this Flower, tho' it be deeply divided in four Segments, is yet really Monopetalous, and falls off all together into one; such as Speedwell or Fluellin, Wild Poppy, Yellow Poppy, Loose Strife, Spurge, and Plantain, (according to Mr. Ray.)

19. *Leguminous Plants*, (or such as bear Pulse,)

with a *Papilionaceous Flower*. Their Flower is Difform, and almost in the Form of a Butterfly and Wings expanded, (whence the Name *Papilionaceous*;) consisting of four parts, joined together at the Edges; these are Pease, Vetches, Tares, Lentils, Beans, Liquorice, Birdsfoot, Trefoil, Restharrow, &c.

20. *Vasculiferous Plants*, with a *Pentapetalous Flower*. These, as the 16th and 18th Kind, have besides the common Calyx or Cup of the Flower, a peculiar Case containing the Seed, and their Flower consisting of 5 Leaves; such as Maiden Pinks, Campions, St. John's-Wort, Male Pimpernel, Chickweed, Cranebill, Flax, Primrose, Periwinkle, Centory, Wood Sorrel, Marsh Trefoil, &c.

21. *Plants with a true Bulbous Root*. A Bulbous Root consists of but one round Ball or Head, out of whose lower Part or Basis there go many Fibres or Strings to keep it firm in the Earth. The Plants of this Kind, when they first appear, come up with but one Leaf, and the Leaves are nearly approaching to those of the Grass Kind of Plants, for they have no Foot-stalk, and are long and slender: The Seed Vessels are divided into three Partitions; their Flower is usually *Hexapetalous*, or seemingly divided into six Leaves or Segments; such as Garlick, Daffodil, Hyacinth, Saffron, &c.

22. Such as have their Roots approaching to a Bulbous Form. These emit at first coming up but one Leaf, and in Leaves, Flowers, and Roots, resemble the true Bulbous Plants; such as *Flower de Lis*, Cuckoo-pint, Orchis, Broom-Rape, Bastard Hellebore, Tway-blade, Winter-green, &c.

23. *Culmiferous Plants*, with a Grassy Leaf, and an Imperfect Flower. Culmiferous Plants are such as have a smooth, hollow jointed Stalk, with one long sharp-pointed Leaf at each Joint, encompassing the Stalk, and set on without any Foot-stalk: Their Seed is contained within a Chaffy Husk; such as Wheat, Barley, Rye, Oats, and most Kinds of Grasses.

24. Plants with a Grassy Leaf, but not *Culmiferous*, with an Imperfect or Stameneous Flower; as Cypress Grasses and Rushes, Cats Tail, Burr Reed, &c.

25. Plants whose Place of Growth is uncertain and various, but chiefly Water Plants, as the Water Lilly, Water Millfoil, Water-wort, Pepper-grass, Mouse-tail, Milkwort, Dodder, &c.

There is also another usual Division of Plants into *Trees*, *Frutices* or *Shrubs*, *Suffrutices* and *Herbs*; but this is rather Popular and Vulgar, than Just and Philosophical.

PLANTING, [in *Architecture*] signifies the disposing of the first Courses of solid Stone on the Masonry of the Foundation, laid Level according to the Measures with all possible Exactness.

PLASM,



PLASM, the same with a Mould in which any Metal, or such like running Matter, which will afterwards harden, is cast.

PLASTIC *Virtue*, is a Faculty of forming, or fashioning any thing.

PLASTICE, or the *Plastick Art*, is the Art of making Figures of Men, Birds, Beasts, Fishes, Plants, &c. in Clay, &c. The Workmen are called *Plastæ*. It differs from Carving, because here the Figures are made by *Addition* usually, but in Carving always by *Subtraction* of what is superfluous. It is now with us chiefly used in Fret-work Cielings; but the *Italians* apply it to the Mantlings of Chimneys with great Figures.

PLAT-Bastion. See *Bastion*.

PLAT-Band, in Architecture, is a Square-Mould which terminates the Architecture of the *Dorick Order*, or the *Fascia* which passeth immediately under the *Triglyphs*, and serves for the same Use in this Order, as the *Cymatium* in the others. It is also the *Fascia* of the *Chambranles*: And the same Name is also attributed to divers other Members of Architecture, which are destitute of Ornament, having only a certain Breadth without much Projecture.

PLATES, a Term in *Heraldry*. See *Balls*.

PLATFORM, in Fortification, is a Place prepared on the Ramparts for the raising of a Battery of Cannon; or it is the whole Piece of Fortification raised in a re-entring Angle. See *Battery*.

PLATFORM, in Architecture, is a Row of Beams that support the Timber-Work of a Roof, and lie on the top of the Wall, where the Entablature ought to be raised. Also a kind of Terrass Walk, or even Floor on the Top of a Building; from whence we may take a fair Prospect of the adjacent Gardens or Fields. So an Edifice is said to be covered with a *Platform*, when it hath no Arched Roof.

PLATFORM, or *Orlop*, in a Man of War, is a Place on the Lower Deck of her, abaft the Main Mast, and round about the Main Capstan, where, in the Time of Service, Provision is to take care of the Wounded Men; 'tis between the Main Mast and the Cock-pit.

PLATISMA, is a broad Linen-cloth put upon Sores.

PLATONICK *Bodies*. See *Regular Bodies*.

PLATTOON, corruptly from the *French Word Pelatoon*, is a small Square Body of Musqueteers, such as is easily drawn out of a Battalion of Foot, when they form the Hollow Square to strengthen the Angles; and the Granadeers are generally thus posted.

PLATTS in a Ship, are flat Ropes made of Rope-yarn, and weaved one over another; their Use is to save the Cable from Gallings in the Haufe, or to wind about the Flukes of the Anchors to save the Pendant of the Fore-sheet from gallings against them.

PLAY. The Laws of Chance or the Proportion of Hazard in Play or Gaming is a Thing Mathematically computable, &c. For tho' it be usually very uncertain in any Game depending on Chance, who shall win; yet it may, in most Cases, be determined who hath the better of the Lay, and what Advantage one hath above the other; (which if Gentlemen knew and considered, they would not, perhaps, venture their Money with

Sharpers, and such Wretches at make it their whole Business to *know* and *remember* the Odds in Gaming, as well as to practise most infamous Ways of Cheating by false Dice, flight of Hand, &c. But, I proceed to an easy Instance; tho' whether a Man shall throw 6 with one Die the first time be uncertain, yet how much it is against him, or how improbable that he doth not, may easily be determined. So likewise if another and I play at Tables or Back-Gammon, 3 up, and I am the first one; tho' it be uncertain, and can't be determined Mathematically who shall win; yet by those Principles I can demonstrate what the Advantage is on my Side, and how much the Value of my Expectation or Chance exceeds his.

A vast Variety of Questions about these Things will arise in Play, amongst two or more Gamblers; in Order to the Determination of which, this must be premised as a Principle.

*That the Value of any one's Chance or Expectation of Winning, is what would purchase the like Chance; Advantage or Expectation in a just or equal Game.*

Thus if a Person should, unknown to me, hide in one Hand 7 s. and in the other 3 s. tho' it be impossible for me to be certain which Number is in which Hand; yet I'm sure 'tis an Advantage to me to have the Choice of which Hand I will take; and (as I shall shew below) this Advantage is worth five Shillings.

In order to which, I lay down this Proposition.

#### Proposition I.

Where there is an equal Chance for  $a=3$  s. and  $b=7$  s. the Value of my Expectation is  $\frac{a+b}{2}$ ; or half the Sum of  $a$  and  $b$ .

To investigate the truth of which Proposition; suppose I would seek what the value of my Expectation is in this Case, let it in the Analytick way of Enquiry, be called  $x$ .

Then, by the general Axiom or Principle, If I had  $x$ , I were able in a fair and equal Game to purchase such an Expectation again.

Suppose therefore I play with another on these Terms, that each of us shall Stake down  $x$ , and that the Winner shall give  $a$  to the Loser: I say this is just and fair, and that I have an equal Chance, either to get  $a$ , if I lose the Game, or to have  $2x-a$  (that is, both the Stakes, subtracting  $a$ ) if I win. Now to make it an equal Game, this  $2x-a$  must be  $=b$ , wherefore transposing  $a$  and dividing by 2, you will have this Equation  $x = \frac{a+b}{2}$ , which gives  $x$  sought.

Thus in Numbers, If I have an equal Chance of getting 3 s. or 7 s. then by this Proposition my Expectation or Interest is worth 5 s. and 'tis certain, that having 5 s. I may have the same Chance; for if I play with another, and each of us Stake 5 s. with this Condition that the Gainer shall pay the Loser 3 s. This is an equal Way of Gaming; and 'tis plain, That I have an equal Chance to get or receive 3 s. if I lose, or 7 s. if I win.



That is, if a Man will give me the Choice of 7 s. in one of his Hands, and 3 s. in the other, 'tis as good as giving me 5 s.

*Proposition II.*

Where there is an equal Chance of  $a$ ,  $b$ , or  $c$ , the value of my Expectation is  $\frac{a+b+c}{3}$ , or one third of the Sum of  $a$ ,  $b$ , and  $c$ .

Let  $x$  (as before) be the Value of my Expectation; then must  $x$  be such, that I can purchase with it the same Expectation in a just and equal Game. Suppose the Conditions of the Game were, that of three Gamesters each of us stake down  $x$ , and I agree with one of them, to give him  $b$  if I win, and he doth the same by me; with the other I agree to give  $c$ , if I win; and he doth the same with me: I say, this is fair and equal Play; for here I have an equal Chance to get  $b$ , if the first win,  $c$  if the second win; or  $3x - b - c$  (that is, all the Stakes, deducting  $b$  and  $c$ ) if I win my self. Now to make the Game equal,  $3x - b - c$  must be equal to  $a$ , wherefore  $x = \frac{a+b+c}{3}$ . And so on; if there had been an equal Chance for four Things as  $a+b+c+d$ , the Value of my Expectation will be  $x = \frac{a+b+c+d}{4}$ , &c.

*Proposition III.*

Let the Number of Chances by which 13 (=  $a$ ) may happen to me, be  $p=3$ , and the Number of Chances by which  $b=8$ , falls to me be  $q=2$ , and supposing all the Chances to happen with an equal Facility; then, I say, the Value of my Expectation is  $\frac{pa+qb}{p+q}$ ; that is, in Words, The Quotient arising from the Sum of the Products of both the Numbers  $a$  and  $b$ , when multiply'd into their Respective Chances  $p$  and  $q$ , and then divided by the Sum of those two Chances. To prove which,

Suppose as before my Expectation to be  $x$ : If I have  $x$ , I shall be able to purchase with it the same Expectation again in an equal Game. For this I may take in as many Persons to play with me as make up the Number of  $p+q$ ; of which every one must stake  $x$ , therefore the whole Stake will be  $px+qx$ , and every one plays with equal hopes of winning.

With as many of my Fellow-Gamesters as the Number  $q$  stands for, I bargain one by one, that which of them soever wins shall give me  $b$ ; and if I win, I will do so by them. Then with the rest of the Gamesters, whose Number is  $p-1$  (that is, all the remaining Gamesters but those express'd by  $q$ , and my self) I bargain, that whoever of them gains the Stakes shall give me  $a$ , and I agree to do so by them, if I win. 'Tis plain, that this is fair Play, no Man being injured. And in this Case I have  $q$  Expectation to gain  $b$ ; and  $p-1$  Expectation to win  $a$ : And 1 Expectation (*viz.* If I win my self) to gain  $px+qx-bq-ap+a$ ; for if I win I must give  $b$  to each of the  $q$  Gamesters, and  $a$  to each of the  $p-1$  Players; which makes

$ab+pa-a$ ; if therefore  $qx+bx-ba-ap+a$  were equal to  $a$ , I should have  $p$  Expectations of  $a$ ; (since just now I had  $p-1$  Expectations of it) and  $q$  Expectations of  $b$ ; and so I should come just to my first Expectation; wherefore putting  $px+qx-bq-ap+a=a$ . By Reduction  $x = \frac{ap+bq}{p+q}$ . Q. E. J.

In Numbers, If I have 3 Chances for 13, and 2 Chances for 8, I say by this Rule my Expectation is worth 11.

For  $13 \times 3 = 39$ , and  $8 \times 2 = 16$ , and  $39 + 16 = 55$ , and  $55 \div 5 = 11$ .

And if I have 11, I can easily shew that I may come to this Expectation: For, suppose I play with 4 others, each of which, as well as I, stakes 11; with two of these I bargain, that whoever of us wins shall give the others 8 a-piece; and then with the other 2, I agree, that the Winner shall give to the 2 Losers of us 13 a-piece. Then 'tis plain, I have 2 Expectations to get 8, and 3 Expectations to get 13 (*viz.* if either I or any of the other two win) for in this Case I gain all the Stakes which make 55; out of which I must give the first two 8 a-piece, and the other two 13 a-piece, and so there remains 13 for my self.

To apply these things to the ordinary Cases of Play.

1. Suppose he that come first to Three be up, or wins the Stake between two Gamesters: And let me be two and he but one; Query, What is my Advantage? Or, if we leave off Play, what is my just Share of the Stakes?

The first Consideration here is, how much each of us wants to be up; as suppose we play 3 up, and he be 1 and I 2; or if we play, first come to 20, and he be 18 and I 19 Games; in both these Cases he wants 2 of being up, and I want but one, The Question is, what Advantage I have of the Lay? or what Proportion of the Stakes is due to me if we should now leave off.

To find which, let us see what would happen if the Game went on: If I get the next Game, or End, I am up, and win the Stakes; which suppose you call  $a=8$ , but if he win 2, then he will be up as well as I, and so both our Lots are equal; and if we should then divide, each of our Shares will be  $\frac{a}{2}$  or  $\frac{1}{2}a$ .

But before we play that Game, if I am two and he but one, the Hazard, which of us shall win that Game, being equal, I have an equal Chance to get the whole Stake or the half; that is,  $a$  or  $\frac{a}{2}$ ; for if I win the Game I have  $a$ , and if he win, my just share of the Stake is  $\frac{1}{2}a$ .

Since therefore, before I begin this Game, I have an equal Chance to gain  $a$  or  $\frac{1}{2}a$ , the Value of my Expectation (by Prop. I.) is half the Sum of both those Chances (*i.e.*)  $\frac{a+\frac{1}{2}a}{2} = \frac{3}{4}a = 6$ . Now if I have  $\frac{3}{4}a$  due to me as my Share, he can have but  $\frac{1}{4}a$  due to him as his Proportion, so that if we play'd for 8 Pieces, and would draw Stakes when I am two, and he but one, and if three be up, I must have 6 Pieces and he but 2 Pieces, and the Odds on my side is Three to One.

Another way thus; in

Case 1. The Deficiencies being 3, the Sett must be up in two Ends; wherefore take the Members of



of the 2d Power of  $a+b$ , and distribute them thus: Because  $A$  wants but one of up, let all the Members, where there is one  $a$  or more, with their *Unciæ* be collected for  $A$ , and all where there's two  $b$ 's (or  $bb$  and above) for  $B$ .

For $A$ .	For $B$ .	
1 $aa$	1 $bb$	Wherefore $A$ 's odds to $B$ is 3 to 1.
2 $ab$		
3	1	

Or by simple Subtraction only, Let the Stake of each be 32 s. then if  $A$  wins the next Game he is up and hath the whole or 64 Shillings; but if  $B$  wins it, their Shares will be equal.  $A$  there might have said, If  $B$  will leave off let him give me the 32 Shillings, which I am sure of, tho' he should win the next Game; and since he will not venture for the other 32 s. let us divide it fairly between us; so  $A$  must have 16 s. more, which will make his Share in the whole 48 Shillings, and he must have only 16 Shillings.

'Tis the same odds, *i. e.* 3 to 1, that a Man throws not Pile twice together with one Piece, as that he throws two Piles the first throw with two Pieces.

For reckoning each Face of the Piece of Money for a Chance, like the Face of a Dye, 'tis plain, of the 4 Chances on the two Pieces, there is only two Piles for him, whereas there is 2 Crosses, one Pile and one Cross, and one Cross and one Pile against him; (each Piece having two Faces) that is, there is one for him and 3 against him.

*Case 2.* Suppose I want but one Game of up, and my Fellow-Player 3.

I consider the State of our Case, if either my self or he gain the next Game. If I win it I am up, and so have the Stake  $a$ ; if he win it, he will then want two of being up, as I want but one. And then I shall be in the same State as was supposed in the Case before this; and my Share of the Stakes, if we should divide fairly, is  $\frac{3}{4}a$ ; wherefore before I threw I had an equal Chance for  $a$  or  $\frac{3}{4}a$ , and therefore (by *Proposition I.*) my Expectation is worth  $\frac{a + \frac{3}{4}a}{2} = \frac{7}{8}a$ . But if my Proportion of Expectation be  $\frac{7}{8}a$ , his can be but  $\frac{1}{8}a$ ; and therefore my Odds is as 7 to 1.

Otherwise thus,

The Deficiencies being 4, the Set must be up at 3 Games End: Then take the Members of the third Power of  $A+B$  and distribute them thus:

For $A$ ,	For $B$ ,	
1 $a^3$	1 $b^3$	Wherefore the Odds is as 7 to 1.
3 $aab$		
3 $abb$		
7	1	

Here also by common Subtraction 'tis plain; That if  $A$  wins the Game he hath 64 s. but if  $B$  wins it, they are in the Condition mentioned in *Case 1.* That is, there is then 48 s. due to  $A$ ; wherefore he might say, Give me that 48 s. that is due to me (for I am sure of it whether I win or lose the next Game) and if you will leave off and not hazard the other 16 s. let us divide them

equally; give me 8 s. more, which makes my Share 64 s. leaving yours but 8 s. wherefore  $A$ 's Advantage was 7 to 1.

*Case 3.* By this Method of Calculation you will find, that if I want but one of being up and he 4, the Odds on my Side is 15 to 1.

*Case 4.* Suppose I want two and he three Games of being up.

Then if I win the next, I shall want but one and he three. This State of the Sett is worth  $\frac{7}{8}a$  by the last *Case*; but if he win, then each of us will want 2, and so our Chance is equal, and there is  $\frac{1}{2}a$  due to each of us; wherefore I have an equal Chance to gain  $\frac{7}{8}a$  or  $\frac{1}{2}a$ : But  $\frac{\frac{7}{8}a + \frac{1}{2}a}{2} = \frac{11}{8}a$ .

wherefore, if we were to divide the Stakes justly, there is eleven 16ths due to me, and consequently but five 16ths due to him; wherefore I must have eleven parts of the Stake, and he but five.

Otherwise thus;

Let  $A$  want 2 of up, and  $B$  want 3.

The Deficiencies 2+3 being 5, the Sett must be up in one Game less; *viz.* 4.

I take therefore the 4th Power of the Binomial  $A+B$ , *viz.*  $a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$ , and distribute it thus;

Let all the Members where there are two  $a$ 's be collected for  $A$ , and all those where there are three  $b$ 's for  $B$ .

$A$ .	$B$ .	
1 $a^4$	4 $b^3a$	Then adding all the <i>Unciæ</i> in each Collection together they will give the Chances and shew the Odds of $A$ 's winning or being up before $B$ , to be as 11 to 5.
4 $a^3b$	1 $b^4$	
6 $a^2b^2$		
11	5	

And so on Universally.

As in *Case* the next, where  $A$  wants two and  $B$  wants four of up.

The Deficiencies being 6, the Sett will be up in one Game less, *viz.* 5. Taking therefore the *Unciæ* of the 5th Power of  $a+b$  you will have

for $A$ .	for $B$ only	
1 $a^5$	1 $b^5$	Wherefore the Odds is 26 to 6, or 13 to 3.
5 $a^4b$	5 $ab^4$	
10 $a^3b^2$		
10 $a^2b^3$		
in all 26	in all 6.	

This Method by the *Uncia* of a Binomial was communicated to me by the Honourable Francis Roberts, Esq;

*Case 5.* Suppose I want 2 and he 4.

If I win next I shall want but one and he will still want four; but if I lose the next Game, I shall want 2 and he 3; wherefore by *Case 3, 4.* I have an equal hazard of gaining  $\frac{11}{8}a$  or  $\frac{1}{2}a$ , and this by *Prop. I.* is worth  $\frac{13}{8}a$ ; wherefore his Share is but  $\frac{1}{8}a$ , and therefore the Odds on my Side is 13 to 3.

*N. B.* Wherefore he that wants but 2 of up, when the other wants 4, is in a better State than he who wants but one when the other wants but two (as in *Case 1.*) for his Expectation then is but  $\frac{3}{4}a$  or  $\frac{1}{2}a$ , whereas now 'tis  $\frac{13}{8}a$ .



To carry this a little farther, Suppose 3 Men at play, and let the first and second want but one Game of up; and the third want two.

To find the value of the Share of the first (in Case of a Division of the Stakes) you must consider what will happen if either he or any of the two other gain the first Game. If the first win he gets the Stake  $a$ , if the second win, the first hath Nothing; but if the third win, each would want a Game; so that  $\frac{1}{3}a$  is each Man's Share: Wherefore the first Man hath one Expectation to gain  $a$ , one to get nothing, and one for  $\frac{1}{3}a$ ; which by *Prop. II.* is  $\frac{a+0+\frac{1}{3}a}{3} = \frac{4}{9}a$ . But the second

Man's Expectation was as good as that of the first, for he wanted also but one of up; wherefore his also is  $\frac{4}{9}$  of  $a$ : But  $\frac{4}{9}a + \frac{4}{9}a = \frac{8}{9}a$ , and consequently the Third's Share can be but  $\frac{1}{9}a$ ; wherefore the Stakes being divided into 9 parts, the two first Men must have 4 a-piece, and the third must have one.

And after this manner you may proceed with any Number of Players; of which some want more and some less of the Setts of Games. If you go about to investigate any one's Share, you must consider what would be due to him, if either he or any one Gamester should win the next Game; and then, *adding all their Shares, and dividing the Sum by the Number of the Gamesters, the Quotient will be the Share you seek.*

#### Proposition IV. Problem.

To find at how many Throws one may undertake to throw 6 with one Dye?

*Case 1.* If I undertake to throw six the first time tis plain there is but one Chance for me, and 5 against me. Let the Stake therefore be  $a$ , then shall I have one Expectation to gain  $a$ , and 5 to gain Nothing; wherefore by *Prop. II.*  $\frac{a+5 \text{ nothing}}{6}$

(for 5 times Nothing is Nothing)  $= \frac{1}{6}a$ , is the Value of that Expectation, and consequently my Antagonist must have  $\frac{5}{6}a$ ; wherefore he ought to lay me 5 to 1.

*Case 2.* If I undertake to throw 6 at 2 Throws with one Dye, my Chance may thus be found;

If I throw 6 the first time, I have my Stake; if I do not, I have but one throw remaining; which (by *Case 1.*) is  $= \frac{1}{6}a$ ; wherefore there are five Chances for my gaining  $\frac{1}{6}a$ , and but one for  $a$ ; which (by *Prop. II.*)  $\frac{a+\frac{5}{6}a}{6} = \frac{11}{36}a$ , the Chances against me then give my Fellow Gamester  $\frac{25}{36}a$ , and consequently, that I don't throw 6 at two Throws, is 25 to 11.

*Case 3.* By the same Method of Calculation you will find that I don't throw 6 at three times is 125 to 91, a little more than 4 to 3.

*Case 4.* That I do throw it at 4 times is 671 to 625, a little more than an even Wager.

*Case 5.* That I do it at 5 times, is 4651 to 3125, viz. almost 3 to 2.

*Case 6.* That I do it at 6 times, is 31031 to 15625, almost 2 to 1.

The Solution of this Problem and of the following one I had also from the Honourable *Fr. Roberts, Esq;* Thus,

In how many times, with a single Dye, may one undertake to cast Six?

The Chances of one Dye being 6, I make 6 the Numerator of a Fraction, and the Chances against my throwing 6 being 5, I make that the Denominator; and by Consequence, the *Denominator subducted from the Numerator leaves the Chances which are for me.*

Now I say, that the Number of Throws requir'd must be the Index of that Power of  $\frac{6}{5}$ , which makes the Numerator at least double to the Denominator; for by that Means the Chances against me being subducted, a Majority will remain for me.

Throws	$\frac{6}{5} \times \frac{6}{5} \times \frac{6}{5} \times \frac{6}{5}$	
1 { makes it	5 ag <sup>n</sup> me	{ 1 for me
2 {	25	{ 11
3 {	125	{ 91
4 {	625	{ 671

that is 36—25  
216—125  
1296—625

Wherefore at 4 Throws I have something the Advantage: And so you may proceed on as far as you please.

*Problems* of this Nature are very expeditiously solved by the *Logarithms*, as in this Example.

In how many times, with six Dice, may one undertake to throw all Sixes?

All the Chances on 6 Dice being the 6th Power of 6; that is, 46656, let  $x$  be the Number of Throws required.

$x2$	1	46556x	
		— 7	2. that is, this Fraction when
		46655	raised up to the Power of $x$
			must have its Numerator above double of the Denominator; or by the <i>Logarithms</i> .
	2	0.00000931x7 0.30103000.	
	3	Wherefore dividing one by the other, it will follow, that $x732334$ .	
	4	And consequently $x=32335$ .	

Now without the *Logarithms*, (which solve this in a few Minutes) a Man's Life would scarce serve to go thro' the Operation; for  $\frac{46656}{46655}$  must be raised up to the 32335th Power, which would make a Row of Figures almost a Quarter of a Mile in Length.

#### Proposition V. Problem.

To find at how many times one may throw 12 with only two Dice.

*Case 1.* 'Tis plain, the first Throw, the Castor hath but one Way to throw it, and 35 Throws to miss it; wherefore by *Prop. II.* his Expectation is but  $\frac{1}{36}a$ .

*Case 2.* He that undertakes it at twice, if he throw 12 the first time gains  $a$ ; if not, he hath but one Throw more for it; and that is worth but  $\frac{1}{36}a$ , by the former Case; wherefore there is but one Chance for him for 12 at the first Throw, and 35 Chances against him: So that he hath 1 Chance for  $a$  and 35 for  $\frac{1}{36}a$ , which by *Prop. II.*

is

I



is worth  $\frac{71}{1296}a$ , and there will be against him  $\frac{1225}{1296}a$ , which is above 16 to 1.

Omitting then the Chances of doing it at three Throws, let us find the Hazard or Odds of doing it at 4 Throws.

If he that undertakes to throw 12 at 4 Throws do it the first or second Throw, then he hath  $a$ ; if not, there remain two other Throws against him; which by the former Case are worth  $\frac{71}{1296}a$ .

But for the same Reason in his two first Throws, he hath 71 Chances for  $a$ , against 1225 Chances which will lose it; wherefore at first he hath 71

Chances for  $a$ , and 1225 which give him  $\frac{71}{1296}a$ ;

which by the 2d Proposition is worth  $\frac{1500625}{1679610}a$ .

And thus if you pursue all the Cases (saith the ingenious Author of the Laws of Chance, p. 38, 39.) you will find that he that undertakes to throw 12 with two Dice at 24 Throws, has some Disadvantage of the Lay, as he that engages to do it at 25, hath some Advantage.

#### Proposition VI.

After the same manner may be found, that you may undertake to throw two Sixes at ten Throws of one Dye, or with one Throw of ten Dice.

#### Proposition VII.

If I play with another but one Throw with two Dice, so that if 7 comes up, I win the Stake, if 10 he gains it; what is the Odds, and how much of the Stakes would belong to me if we draw?

Of the 36 Chances on the two Dice, there are 6 which will give me 7, 3 which give me 10, and consequently 27 other Chances which give me neither, and which equals the Game; in which Case there is due to each of us  $\frac{1}{2}a$ ; but if none of the 27 should happen, I have 6 Chances to gain  $a$  and 3 by which I may get Nothing; which, by Prop. II. is  $\frac{2}{3}a$  in Value. So I have 27 Chances for half  $a$  and 9 Chances for  $\frac{2}{3}a$ , which (by Prop. II.)  $=\frac{1}{4}a$  for me, and  $\frac{1}{4}a$  for him.

#### Proposition VIII.

If I were playing with another, by turns, with two Dice, so that if I throw 7 I win, and if he throw 6 he wins, and he hath the first Throw; What is the Proportion of my Hazard to his?

Suppose I call the Value of my Hazard  $x$ , then if the Stakes be  $a$ , his Hazard will be  $a-x$ .

Then whenever 'tis his Turn to throw, my Hazard is  $x$ ; but when it is my Turn, the Value of my Hazard is greater.

Suppose I then call it  $y$ . Now because of 36 Throws on two Dice, there are 5 which will give him 6, and 31 which bring it again to my turn to throw; I have 5 Chances for Nothing and 31 for  $y$ , which (by Prop. III.) is worth  $\frac{31}{36}y$ . But at first I supposed my Hazard to be  $x$ , wherefore  $\frac{31}{36}y=x$ , wherefore  $\frac{31}{36}x=y$ . I supposed likewise when it was my Turn to throw, that the Value of my Ha-

zard was  $y$ : But then I have 6 Chances which give me 7, and consequently the Stake; and 30 which give my Antagonist the Dice; that is, make my Hazard worth  $x$ . So I have 6 Chances for  $a$ , and 30 for  $x$ ; which by Prop. 3. is worth  $\frac{6a-30x}{36}$ ,

but by the Supposition, that is  $=y=\frac{31}{36}x$ , and therefore  $\frac{6a-30x}{36}=\frac{31}{36}x$ ; and by Reduction

$x=\frac{1}{4}a$ , which is the Value of my Hazard; wherefore his must be  $\frac{3}{4}a$ , and consequently my Chance to his is as 31 to 30.

In the Book above-mentioned, called *The Laws of Chance*, you will find the Advantages and Disadvantages of the several Chances at Hazard, Raffle, Whist, &c. this Way computed.

#### Proposition IX. Prob.

To find in any Number of Games the Value of the First.

Suppose  $A$  and  $B$  play so that he that wins the first 9 Games shall have the Stakes, and  $A$  hath won one of the 9 already; if they leave off, how much of  $B$ 's Money is due to  $A$ .

To find this, take the first 8 even Numbers, 2, 4, 6, 8, 10, 12, 14, 16, and multiply them continually, that is, the first by the second, and then the Product arising thence multiply by the third, &c. Take also the first 8 odd Numbers, and do so by them. The Product of the even Numbers will be a Denominator, and that of the odd ones a Numerator of a Fraction; which Fraction will express the Quantity of  $B$ 's Money due to  $A$  on his winning the first of the 9 Games.

Suppose only 4 Games up, of which  $A$  is one: Take the three first even Numbers, as 2, 4, 6, and multiply them continually, they will make 48; the three first Numbers 1, 3, 5, so multiply'd make 15: Therefore there is due in this Case to  $A$ ,  $\frac{15}{48}$ , or  $\frac{5}{16}$  of  $B$ 's Money; wherefore, if each had staked 16 Shillings, there would be a Crown due to  $A$  besides his own Stake of 16 Shillings.

#### Proposition X. Probl.

To find the Value of his Hazard who undertakes at the First Throw to cast Doublets with any assigned Number of Dice.

In two Dice, 'tis plain, that to avoid Doublets, every one of the Six different Throws of the first Dye, can only be combined with Five of the Second; because one of the Six is of the same kind; and therefore will make Doublets.

For the same Reason, the 30 Throws of 2 Dice which are not Doublets, can only be combined with four Throws of a third Dye, and with but 3 Throws of a fourth Dye.

Wherefore in General this will be the Series.

$$\frac{6 \times 5 \times 4 \times 3 \times 2 \times 1 \times 0, \&c.}{6 \times 6 \times 6 \times 6 \times 6 \times 6 \times 6, \&c.}$$

The Under Series is the Summ of all the Chances; and the Upper, the Number of Chances against him who undertakes to throw Doublets.



Each *Series* must be continued to so many Terms, as are the Number of Dice. *V. gr.* If one should undertake to throw Doublets, the first Throw with four Dice, his Adversary's Hazard is  $\frac{5 \times 5 \times 4 \times 3}{6 \times 6 \times 6 \times 6} = \frac{360}{1296} = \frac{5}{18}$ , and he hath  $\frac{13}{18}$ : So that 'tis 13 to 5 that he throws Doublets the first time with four Dice.

In Seven Dice, 'tis easie to see the Chances against the Undertaker are nothing, because then there must necessarily be Doublets.

*Proposition XI.*

If I have  $p$  Chances for  $a$ ;  $q$  Chances for  $b$ ; and  $r$  Chances for  $c$ : I say, my Expectation is worth  $\frac{ap+bq+cr}{p+q+r}$ , that is, in Numbers, supposing  $p=2$ .  $a=3$ .  $q=4$ .  $b=5$ .  $r=1$ .  $c=9$ ; the Value of my Hazard is  $\frac{2 \times 3 + 4 \times 5 + 1 \times 9}{7} = 5$ . For

call my Expectation  $x$ , then  $x$  must be such, as having it, I am able to purchase as good a Hazard again, in a just and equal Game. Suppose the Law of the Play were this, that I playing with so many others, as with my self, make up the Number  $p+q+r$ ; with as many of them as the Number  $p$  represents, I make this Bargain, that whoever wins shall give me  $a$ , and I will do so to each if I win: With those represented by the Number  $q$ , I bargain to have  $b$  if any of them win, and to give  $b$  to each of them if I win my self; and with the rest of the Players, whose Number is  $r-1$ , I agree to give or to receive  $c$  after the same Manner. Now all being in an equal Probability to gain, I have  $p$  Chances to get  $a$ ,  $q$  Chances for  $b$ , and  $r-1$  Chances to get  $c$ , and one Chance, *i. e.* when I win my self, to get  $px+qx+rx-ap-bq-rc+c$ , which if it be supposed equal to  $c$  then I have  $p$  Chances for  $a$ ,  $q$  Chances for  $b$ , and  $r$  Chances for  $c$  (for just now I had  $r-1$  Chances for it) therefore if  $px+qx+rx-ap-bq-rc+c=c$ : Then is  $x = \frac{ap+bq+cr}{p+q+r}$  as it ought to be.

By this Theorem all the Chances at Hazard may easily be calculated. Vid. *Laws of Chance*, p. 87.

PLAYNT, in Law, is the propounding, or exhibiting of any Action Real or Personal in Writing; and the Party making this *Playnt*, is called *The Party Plaintiff*.

PLEA, in Law, signifies that which either Party alledgeth for himself in Court, and are either *Pleas of the Crown*, or *Common-Pleas*. *Pleas of the Crown*, are all of them Suits in the King's Name, against Offences committed against his Crown and Dignity, or against his Crown and Peace; and those seem to be Treasons, Felonies, Misprisions of either, and *Maibem*. *Common Pleas* be those that are held between Common Persons, yet by the former Definitions, they must comprise all other, tho' the King be a Party. *Plea* may farther be divided into as many Branches as *Action*; which see, for they signify all one.

Then there is a *Foreign Plea*, whereby Matter is alledged in any Court, that may be tried by another.

PLEAS of the Sword. *Placita ad Gladium*. In 2 H. III. Ranulph Earl of Chester granted to his Barons of *Cheshire* an ample Charter of Liberties, *Exceptis Placitis ad Gladium suum pertinentibus*. The Reason of which was, that William the Conqueror gave the Earldom of *Chesster* to his Kinsman Hugh (commonly called *Lupus*) Ancestor to this Earl Ranulph, *Tenere ita Libere per Gladium, sicut ipse Rex Willhelmus tenuit Angliam per Coronam*. And consonant hereunto, in all Indictments for Felony, Murder, &c. in that County Palatine, the Form was anciently, *Contra Pacem Domini Comitis, Gladium & Dignitates suas*.

PLEADINGS, in Law, are all the Sayings of the Parties to Suits after the Count or Declaration; to wit; whatever is contained in the Bar, Replication, and Rejoinder, and not in the Count itself; and therefore Defaults in the Matter of the Count, are not comprised within *Mispleading*, or insufficient *Pleading*, but only *Mispleading*, or insufficient *Pleading*, committed in the Bar, Replication, or Rejoinder.

PLEBANIA, *Ecclesia plebanianis*, is a Mother-Church which hath one or more subordinate Chapels.

PLEBANUS, was sometimes the Title of a Rural Dean, because the Deanries were formerly affixed to the *Plebania*, or chief *Mother Churches* within such a District, which at first was usually Ten Parishes. Sometimes it seems to have been used for a Parish-Priest of such a large Mother-Church as was exempt from the Jurisdiction of the Ordinary, and therefore he had the Authority of a Rural Dean committed to him by the Archbishop, to whom the Church was immediately subject.

PLEBISCITUM, in the *Roman Law*, was whatever was enacted by the Common People, at the Request of the Tribune, or some other *Plebeian Magistrate*.

PLEDGES, in Common Law, are Sureties either real or formal, which the Plaintiff finds to prosecute his Suit.

PLEGIIS *acquietandis*, is a Writ that lies for a Surety, against him for whom he is Surety, if he pay not the Money at the Day.

PLEIADES, [*πλειάδες* of *πλείονες*, Gr. *more*] the same with those seven Stars in the Neck of the *Bull*, which are usually thus called.

PLENA *foris factura*, & *plena vita*. See *Forfeiture*.

PLENARTY, in Law, is when a Benefice is full; directly contrary to *Vacation*, which signifies the being void of a Benefice.

PLENILUNIUM, [in *Astronomy*] that Phase or State of the Moon, vulgarly called the Full Moon.

PLENITUDE, is when a Man hath too much Blood; the same with *Plethora*.

PLEONASMUS, [*πλεονασμός*, Gr.] is a Figure in Discourse, when a Word not necessary is added, to express a Vehemency in us, and a greater Certainty in the Thing; as when we say, I saw it with these Eyes: Here, *saw it*, is really enough in Grammar, but *with these Eyes*, is added, to shew both the Certainty of the Fact, and our Zeal and Vehemence in asserting it.

PLEROTICA, [*πληρωτικά* of *πληρώω*, Gr. *to fill up*] are Medicines that breed Flesh, and fill up Wounds.

PLETHORA,



**PLETHORA**, [ $\pi\lambda\eta\theta\acute{\alpha}\rho\alpha$  of  $\pi\lambda\eta\theta\omega\rho\acute{\epsilon}\omega$ , Gr. *to fill up*] when there's more Blood than is requisite: It happens either to the Vessels, when they are stretch'd out, and cannot hold all; or to the Strength, for sometimes, tho' the Vessels be not over full, the Strength is over-loaded.

**PLEVIN**, in Common Law, signifies a Warrant, or *Assurance*. See *Replevin*.

**PLEURA**, [ $\pi\lambda\epsilon\upsilon\rho\acute{\alpha}$ , Gr.] is a double Membrane, which covers all the inward Cavity of the *Thorax*; it arises from the *Vertebræ* of the Back, and ascends on each side upon the Ribs, to the middle of the *Sternum*. It is fixed to the *Periosteum* of the Ribs, and to the internal intercostal Muscles, and it covers the Midriff. Its Side towards the Cavity is smooth and equal, but that which is fixed to the Ribs is Rough.

**PLEURITIS**, [ $\pi\lambda\epsilon\upsilon\rho\iota\tau\iota\varsigma$ , Gr.] a *Pleurisie*, is an Inflammation of the Membrane *Pleura*, and the Intercostal Muscles, attended with a continual Fever, and Stitches in the Side, Difficulty of Breathing, and sometimes Spitting of Blood; and it's either a true *Pleurisie*, as this which we have described, or a Bastard *Pleurisie*, whose Symptoms are not so violent, and in some Things different from the former.

**PLEXUS Choroides** seems to hang over the Pineal Glandule, as it were over a Button. It is an admirable Contexture of small Arteries in the Brain like a Net.

**PLEXUS Nervosus**, is when two or three Nerves meet together, and jut out.

**PLEXUS reticularis**. Vid. *Choroides*.

**PLICA**, is an Epidemical Disease in *Poland*, when their Hairs grow together like a Cow's Tail; besides, they are Crooked-back'd, have loose Joints, it wrenches their Limbs, and loosens them, breeds Lice, with other Symptoms.

**PLINTHUS**, or *Plinthis*, [ $\pi\lambda\acute{\iota}\nu\theta\iota\varsigma$ , Gr.] in Architecture, is taken for that Square Member which serves as a Foundation to the Base of a Pillar: But *Vitruvius* calls the upper part, or *Abacus* of the *Tuscan* Pillar, a *Plinth*, because it resembles a square Tile.

Moreover, the same Denomination is sometimes attributed to a thick Wall, wherein there are two or three Rows of Bricks advanced in form of a *Plat-band*. This

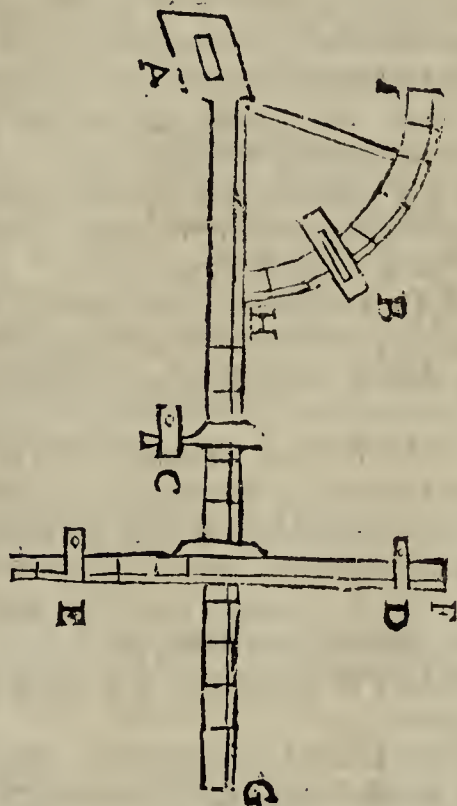
**PLINTH Palladio** calls the *Orle*, and *Blondell* the *Abacus*. The Word is also used for a like Member about the Capital of a Pillar; but then 'tis called always the *Plinth* of the *Capital*, and is placed just above the *Echinus* in the *Dorick*, and above the *Ovolo*, or quarter Round, in the other Orders.

**PLOT**, [in *Surveying*] the Plan or Draught of any Piece or Parcel of Ground, as a Field, Farm or Manour survey'd by a proper Instrument, and laid down in the proper Figure and Dimensions.

**PLOTTING**, [in *Surveying*] the Art of Describing or laying down on Paper, Vellum, &c. the several Angles and Lines of a Tract of Ground, that has been survey'd by a Theodolite or other Instrument, Chain, &c.

**PLOW**, is an Instrument made of Box or Pear-tree, used by Seamen to take the Height of the Sun or Stars, in order to find the Latitude: It admits of the Degrees to be very large, and is much esteemed by many Artists, tho' now not much used at Sea. Its Description is thus given by Sir *Jonas Moor* in his Navigation.

There is first a *Staff*, as *ALG*, on which a small Arch, as *HI*, and a Cross, as *EF*, are fitted together with three Vanes, as *A* an Horizontal Vane, *B* a Shade Vane, and *C* a Sight Vane; which is moveable upon the *Staff*.



In order to make an Observation of the *Sun's* Altitude with this Instrument, you must fit on the Horizon-Vane, and then you may place the Shade Vane to any Degree of Altitude in the Divisions of the Arch, so it exceed not the Altitude to be observed, nor be above 10 Degrees (which a little Practice will soon enable you to guess readily at:) for in both these Cases the Divisions on the *Staff* are deficient. Then put on the Sight-Vane, hold up the Instrument, and turn the Back of the Arch to the Sun, and move the Sight-Vane on the *Staff* backwards and forwards, till the Shade of the upper Edge of the Shade-Vane fall on the upper Part of the Slit of the Horizon-Vane; and that at the same time, looking thro' the Sight-Vane, you can see the Horizon thro' the Horizon-Vane; for then will the Summ of the Degrees on the Arch and on the Staff be the Altitude, allowing for the Height above the Horizon and for Refraction. For the Height above the Horizon they usually allow 6 or 8 Inches.

**PLOW-Land, Carucata**, was formerly as much arable Land as one Plow could plough up in one Year. This in the Beginning of the Reign of *Rich. I.* was accounted at 60 Acres; and in the 9th of *Rich. I.* 100 Acres are allowed for a Plow-Land. And this Measure was very different according to Time and Place.

**PLUMB-Line**, the same with *Perpendicular*.

**PLUMBUM ustum**, is a Composition of two Parts of Lead melted in a Pot or Crucible, with one Part of Sulphur then added to it, and kept o'er the Fire till they be burnt all out; the Matter will then be turned into a Black Powder, which they properly call by this Name *Plumbum Ustum*.

**PLUME**, is the Term used by Botanists for that Part of the Seed of a Plant, which in its Growth becomes the Trunk; 'tis inclosed in two small Cavities formed in the Lobes for its Reception; and is not like the *Radicle*, an entire Body, but divided at its loose End into divers Pieces, all closely



cloely bound together like a Bunch of Feathers; whence Dr. *Grew* very properly gives it the Name of *Plume*. In Corn it is that Part, which, after the *Radicle* is shot forth, shoots out towards the smaller End of the Seed, and therefore is by some called the *Acrospire*.

PLURIES, is a Writ that goeth out in the third Place after two former Writs that had no Effect: For first the Original *Capias* issues, and if that speed not, then goeth out the *Alias*, and if that also fails, then the *Pluries*.

PLUS, [in *Algebra*] a Term commonly used for more, its Character is  $+$  thus,  $3 + 6 = 9$  is read 3 Plus 6 is equal to 9.

PLUSH [with *Botanists*] the middle of Anemonies, Roses, &c. which others call *thrum* or *thrumming Heads*, hairy Heads, *Bass*, *Buttons*, *Tuft* or *Wort*.

PNEUMATICE, or *Pneumatics*, [of *πνεῦμα*, *Breath*] a Branch of *Mechanicks*, which considers the Air in its Motion with its Effects; but it is more usually taken for the Doctrine of the Air, or the Laws according to which that Fluid is condensed, rarified, gravitates, &c.

PNEUMATICK Engine, the same with the Air Pump.

PNEUMATICAL Experiments, are such as are made in the exhausted Receiver of the Air Pump, in order to discover the several Properties of the Air and its Influence on other Bodies. Of these you may find great Variety in Mr. *Boyle's* Works, and in the *Philosophical Transactions*; and those made with great Accuracy and Care.

PNEUMATOCELE, [*πνευματοκύλη*, Gr. of *πνεῦμα*, *Wind*, and *κύλη*, Gr. a *Rupture*] is a Windy Rupture, when the Skin of the *Scrotum* is distended with Wind.

PNEUMATODES, is a short Breathing.

PNEUMATOLOGY, [of *πνεῦμα* and *λόγος*, Gr.] the Doctrine and Contemplation of Spirits and spiritual Substances.

PNEUMATOMPHALUS, [*πνευματόμφολος* of *πνεῦμα* and *ὄμφαλος*, Gr. the *Navel*] is a Swelling in the Navel, got by Wind.

PNEUMATOSIS, [*πνευματώσις*, Gr.] is the Generation of Animal Spirits, which is performed in the Cortical Substance of the Brain; the little Arteries there are emptied, and the Spirits distilled, which after they are come as far as the Middle of the Brain, they Actuate and Invigorate all the Nerves.

PNEUMONICA Vena. See *Vena Pneumonica*, in this Vol.

PNEUMONICS, [*πνευμονικά*, Gr.] Medicines good in Diseases of the Lungs, where Respiration is effected.

POCKET of Wooll, is the Quantity of half a Sack. 3 *Instit. Fol.* 96.

PODAGRA. *vid.* *Arthritis*, The Gout in the Feet.

POETICAL, *Rising and Setting of the Stars*: This is peculiar to the Antient Poetical Writers, for they refer the Rising and Setting of the Stars, always to that of the Sun; and accordingly make three Sorts of Poetical Rising and Setting. *Cosmical*, *Acronical*, (or as some write it, *Acronyctal*), and *Heliacal*. See those Words.

POINT, a Point in Geometry, is that which is supposed to have no manner of Dimension, but to be Indivisible in every respect.

The Ends or Extremities of Lines are Points.

If a Point be supposed to be moved any way, it will by its Motion describe a Line.

POINT Blank, a Term in Gunnery, signifying that a Shot or Bullet goes directly forward to the Mark, and doth not move in a Curve as Bombs, and high elevated Random Shots do.

POINT, in Navigation, signifies 11 Degrees, 15 Minutes, or one 32d Part of the Compass: The half of which is 5 Degrees 38 Minutes, which they call a *Half Point*; and the half of this, which is 2 Degrees 49 Minutes, they call a *Quarter Point*.

The Seamen also call the Extremity of any Promontory (which is a Piece of Land running out into the Sea) a *Point*; which is of much the same Sense with them as the Word *Cape*.

They say two Points of Land are one in another, when they are so in a Right Line one against another, as that the Innermost is hindered from being seen by the Outermost.

POINTS of the Compass. See *Compass* and *Rhumbs*.

POINT of Concourse, in Opticks, is that Point where the *Visual Rays*, being reciprocally inclined, and sufficiently prolong'd, meet together, are united in the middle, and cross the Axis. This Point is most usually called the *Focus*; and sometimes the *Point of Convergence*.

POINT of Concurrence, a Term in Perspective. See *Principal Point*.

POINT of Divergence. See *Virtual Focus*.

POINT of Incidence, in Opticks, is that Point on the Surface of a Glass, or other Body, on which any Ray of Light falls: And as some also word themselves, That Point of the Glass, which a Ray parts from, after its Refraction, and when 'tis returning into the *Rare Medium* again.

POINT of Inflection of a Curve. See *Inflection*.

POINT Principal, a Term in Perspective. See *Principal Point*.

POINT Sensible, according to Mr. *Lock*, is the least Particle of Matter or Space which we can discern; and to the sharpest Eyes, is seldom less than thirty Seconds of a Circle, whereof the Eye is the Centre.

POINT of View, [in *Architecture*, &c.] is a Point at a certain Distance from a Building or other Object, whence the Eye has the most advantageous View or Prospect of it.

POINT of Dispersion, [in *Opticks*] is that Point wherein the Rays begin to diverge, commonly called the *Virtual Focus*.

POINT of Reflection, is a Point upon the Surface of a Glass or other Body, from whence a Ray is reflected.

POINT of Refraction, is a Point in the Surface of a Glass or other refracting Surface in which the Refraction is effected.



POINTS [in *Heraldry*] are the Divisions of an Escutcheon into several Squares, sometimes to the Number of 9, and sometimes to 15, some of which are of one Colour or Metal, the others of another; which are also call'd the *Equipollent Points*.

An Escutcheon is also otherwise divided into Points which have several Names and Values, according to their several Places. As



As to the 9 principal Points, A represents the *dexter chief* Point; B, the *middle chief* Point; C, the *sinister Chief*; D, the *honour Point*; E, the *nombril or navel Point*; G, the *dexter Base*; H, the *precise middle Base*.

*Colombiere* makes the Points and their Situations Symbolical. As the several bearings in an Escutcheon are so many Types that represent the commendable Actions of the Persons to whom they are given.

So the Escutcheon it self represents the Body of a Man who perform'd them, and the *Points* or *Parts* signified by these Letters, the principal Parts of the Body: Thus A B C represent the Head; in which the 3 great Faculties reside, D the Neck, where the Ornaments are chiefly born, E the Heart, &c.

POINT [in *Heraldry*] is also an Ordinary which something resembles the Pile, rising from the Bottom of the Escutcheon to the top, very narrow and only taking up two thirds of the Point of the Escutcheon, and when it rises thus it is called, *Point in Point*.

POINT *inverted*, [in *Heraldry*] is when it descends from the Chief downwards, and possesses two thirds of the Chief, but diminishes as it approaches the Point of the Escutcheon, tho' without touching it.

POINT *en Band*, *Point en Barre*, [in *Heraldry*] is when the Point is placed transverse in the Situation of a Bend or Barr, and when it comes from the Sides of the Escutcheon, it is called according to its Situation *Point dexter* or *sinister*.

POINT is also us'd for the lower Part of an Escutcheon which commonly terminates in a Point.

The *Point dexter* is commonly accounted an Abatement due to a Braggadocio. *Point champain* due for killing a Prisoner after quarter demanded. *Point plane*, an Abatement belonging to a Liar, *Point en*, a Diminution belonging to a Coward.

POINTED [in *Heraldry*] as, *a cross pointed*, is one which has its Extremities turn'd off by strait Lines.

POINT *In*, when two Piles are born in a Coat of Arms, so as to have their Points meet together in any part of the Escutcheon. They say, *He beareth two Point in Point*.

POINT *Campion*,  
POINT *Dexter*,  
POINT *Plain*,  
POINT *in Point*, } All Abatements of Honour; which see under that Word.

POINTING *the Cable*, is when the Strands about two Foot from the End are untwisted, in order to make Sinnet of the Rope-yarn, and then to lay them one over the other again, making it less towards the End, where all is made fast together with a Piece of Marlin; the Design of which is partly to keep the Cable from raveling out, but chiefly that none of the Cable may be cut off, and stole away.

POINT *Blank* [in *Gunnery*] signifies a Shot or Bullet to go directly forward in a strait Line to the mark, and doth not move in a Curve, as Bombs and highly elevated random Shots do.

POINTS *of Station*, in Astronomy, are those Degrees of the Zodiac, in which a Planet seems to stand quite still, and not to move at all.

POLAR *Circles*, are two Circles supposed to be drawn parallel to the *Equinoctial* or *Equator*, thro' 23 Degrees 30 Minutes Distance from the *Polar Points*; and that about the *North Pole* is called the *Arctick Circle*, and the other about the *South-Pole*, the *Antarctick Circle*, because opposite to the former.

POLAR *Dyals*, are those whose Planes are parallel to some Great Circle that passes thro' the *Poles*; or parallel to some one of the *Hours*; so that the *Pole* is neither elevated above, nor depressed below the Plane, therefore the Dial can have no Centre, and consequently its *Stile*, *Substile*, and *Hour Lines*, are parallel. This therefore will be an Horizontal Dial to those who live under the *Equator* or *Line*.

In a *Direct Polar Dial*, the Hour Lines must be drawn all parallel to the Hour Line of Twelve.

The *Style* may be either a strait Pin set upright, or a Wyer made to lie parallel to the Plane, and must stand over the Hour-Line of Twelve.

The Length of the Plane may be taken in any Inches, or Parts of Inches, reckoning the Inch to be divided into 10, or 100 Equal Parts.

Then for the *Height of the Style*, say,

As the *Radius* is to the Logarithm of the *Styles Height*, in Parts of Inches,

So is the Tangent of any *Hour-Line*, to the Logarithm of the Distance thereof from the Meridian Line.

*Example.*

Suppose your *Polar Plane* be 12 Inches long, and it be required to put on all the Hour-Lines from 7 in the Morning unto 5 in the Afternoon.

Here you have 5 Hours and 6 Inches on either Side of the Meridian; and before you work the Operation, the Hours and Inches must be reduced into Degrees or Parts, allowing for every Hour or Inch 15 Degrees, or 100 Parts, so you'll have 75 Degrees, and 600 Parts.

Then for the *Styles Height*:

To the *Ar. Co.* of the Tangent 75° }  
(= 5 Hours) — — } 9.428053

Add the Logarithm of the Distance }  
from the Meridian 600 Poles — } 2.778151

Sum = the Logarithm of the *Styles* }  
*Height*, 161 Parts. — } 2.206204

That is, 1 Inch, and 61 Parts of an Inch.

From the *Hours Distance from the Meridian*,

To the Log. of the *Stiles Heig.* 161 Pts. 2.206204  
Add the Tang. 15° (for the 1st Hour) 9.428053

Sum = Radius = Logarithm of }  
the Hours Distance = 43 Parts — } 1.634256



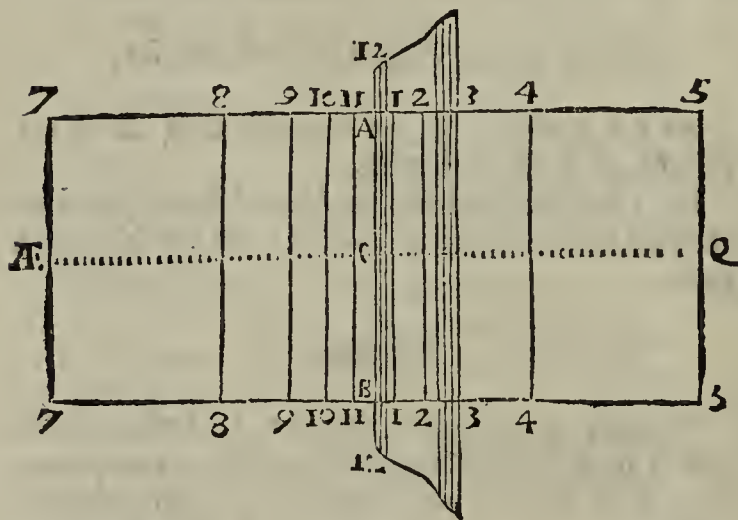
After the same manner may you find the other Hours Distance from the Meridian.

Then draw them in a Table thus :

Hours		Angles at the Poles.		Tangent.	
H.	H.	G.	M.	Inch.	Parts.
12		00	00	00	00
11	1	15	00	00	43
10	2	30	00	00	63
9	3	45	00	1	61
8	4	60	00	2	79
7	5	75	00	6	00
6	6	90	00	Infinit.	

To project the Dyal.

First Draw on the Plane the Meridian Line AB, which cross at Right Angles with  $\text{ÆQ}$ , the *Æquator* : Then from  $c$ , the Intersection of the Meridian and the *Æquator, set off those Parts from the Table both ways, and thro' these Points draw Lines parallel to AB, (or the Hour-Line of 12,) those shall be the Hour-Lines I required.*



POLAR Projection, is a Representation of the Earth, or of the Heavens, projected on the Plane of one of the Polar Circles.

POLARITY, is the Property of the Magnet, or of a Piece of Oblong Iron touch'd by a Magnet, to point toward the Poles of the World.

POLE, in Measuring, is the same with *Perch* or *Rod*, or as some call it, *Lugg*. By our Statute-Law, (*Ann. 35 Eliz. Cap. 6.*) this Measure is a Length of 16 Feet and an half, but it varies by the Usage of some Countries, being in some Places of 18 Feet, which they call *Woodland Measure*; in some Places of 21 Feet, which is called *Church Measure*, (*i. e.* of such Lands as did or do belong to the Church;) and in others of 24 Feet, and this is called *Forest Measure*.

POLE, in Mathematicks, is a Point 90 Degrees distant from the Plane of any Circle, and is a Line perpendicularly erected in its Centre; which Line is called the Axis. And from this Polar Point may Circles be described on the Globe or Sphere, as they are on the Plane from their Centre.

POLE Star, is a Star in the Tail of the *Little Bear*, (a Constellation of 7 Stars, which is called *Cynosura*,) and is very near the exact North Pole of the World. The right Ascension of this Pole Star for this Year, 1700, is 0 Hours 35 Minutes

0 Seconds of Time; and it increases 1 Minute 16 Seconds every 10 Years. Therefore having at any time this Star's Right Ascension, and the Right Ascension of the Sun, (both in time,) if you Subtract the latter from the former, (adding 24 Hours to the Right Ascension of the Pole Star when it is less than the Sun's,) the Remainder will be the Time when the Pole Star is in the Meridian. Then hang up two Strings and Plummets between the Pole Star and your Eye, and you will have a true Meridian Line, which will be of great Use to rectify a Clock or Watch. And you may find the Meridian very nicely, if instead of the Strings above mentioned, you use the Sights of a good Circumferenter, or other Surveying Instrument.

Some Persons have been mighty apt to imagine, That the Height or Elevation of the Pole, and also the Position of the Circles of the Heavens, in respect of those on the Earth, hath much changed and varied: But Mr. Cassini is doubtless right in his Assertion, That there is no just Ground for any such Surmise: And that all the Difference which we find now in the Latitudes of Places, &c. in respect of the Ancient Accounts, arises from the former Observations not being well made; as indeed we may judge they cannot have been, since they had no such good Instruments to do it withal, as the Modern Astronomers have.

Yet he thinks it very probable, that there may be some little Variation in the Height of the Pole, in one and the same Place; but this not exceeding two Minutes, and which will in Process of Time quite vanish, after 'tis arrived to its highest Difference. Vid. *Memoires des Mathemat. & de Physique*, July 1693.

POLE of a Glass (in Opticks) is the thickest part of a Convex, but the thinnest of a Concave Glass, and if the Glass be truly ground, will be exactly in the middle of its Surface: This is sometimes called, The Vertex of the Glass.

POLES of the World, are two Points in the Axis of the *Æquator*, each 90 Degrees distant from its Plane; one pointing North, which therefore is called, The North or *Arctick Pole*; the other Southward, which therefore is called, The South or *Antarctick Pole*.

Whether any People live directly under the Pole or not, is a Question; but Mr. Halley hath proved, That the Solstitial Day, under the Pole, is as hot as under the Equinoctial, when the Sun is Vertical to them, or in their Zenith; because for all the 24 Hours of that Day under the Pole, the Sun's Beams are inclined to the Horizon with an Angle of  $93\frac{1}{2}$  Degrees: Whereas under the Equinoctial, tho' he become Vertical, yet he shines no more than 12 Hours, and is absent 12 Hours: And besides, for 3 Hours 8 Minutes of that 12 Hours he is above the Horizon there, he is not so much Elevated as under the Pole.

POLES of the Ecliptick are Points in the Solstitial Colure 23 Degr. 30 Minut. distant from the Poles of the World; and thro' these all Circles of Longitude in the Heavens do pass, as the Hour Circles do thro' the Pole of the *Æquator*.

To find the Pole of any Circle. See *Spherick Geometry*.

POLEINE, was a kind of Shoe with a picked Point turned up at the Toe: These first came into Fashion in the Reign of William Rufus, and by degrees came to be of that excessive Length, that



that in *Richard the Second's* Time, they were ty'd up to the Knees with Silver or Gold Chains, according to the Dignity of the Wearer. They were forbidden by *Edward the Fourth*, in the fifth Year of his Reign, under a great Penalty, to be worn so very long; but they were not quite disused till the Reign of *Henry the Eighth*.

**POLEMICAL**, is a Word used in reference to that part of Theology which relates to Controversie; which because of the Wars, Jars, and Squabbles, that usually arise about Controverted Points, is called *Polemical Divinity*.

**POLEMOSCOPE**, [of *πόλεμος*, Gr. and *σκοπέω*] an optical Instrument, a kind of crooked or oblique Prospective Glass, contriv'd for the Sight of Objects that don't lye directly before the Eye. So called by *Hevelius* the Inventer, because capable of being us'd in War, Engagements, Duels, &c. There is something of this Kind in Use among us, under the Name of Ogling Glasses, or Opera Glasses, thro' which one may see a Person at the same Time that he seems to be looking at another.

**POLICY of Assurance**, is a Form of Security, mentioned in 43 *Eliz. cap. 12*, & 14; and also in 14 *Car. 2. cap. 23*. and given by a certain Society of Men formed into a kind of Corporation, to any Person to Insure the safe Return of the whole or any part of a Ship; to Insure Houses against Fire; so that if they are burnt down, they shall be Rebuilt at the proper Charge of the Insurers; and to Insure Men's Lives in Offices when they have paid great Sums for the same; and lastly, to Insure to Persons paying so much Money at once, or becoming constant Contributors to the Office or Society of Assurance, a Remainder of so much Money after the said Contributor or Subscriber's Death. This Policy of Assurance is under the Seal of the Office, and entitles the Person benefited by it, to make good his Claim according to the Tenor of the Articles or By-Laws of that Society of which he was a Member.

**POLITICAL Arithmetick**, is the Application of Arithmetical Calculations to the Extent and Value of Lands, Number of People, Publick Revenues, Taxes, Trade, Commerce, Manufactures, or whatever relates to the Power, Strength, Riches, &c. of any Nation or Commonwealth. Of this Nature several Discourses have been published; as *Sir William Petty's Political Arithmetick*; *Grant's Observations on the Bills of Mortality*; *Capt. Halley's* on those of *Breslaw* in *Silesia*; *Dr. Davenant's* Discourses of Trade, &c. From these kinds of Inquiries and Computations, *Sir William Petty* hath advanced, that the Land of *Holland* and *Zealand* is not above 1000000 of Acres, whereas that of *France* is above 80,000000, and yet those Places are near a third Part as rich and as strong. That the Rents of Lands in *Holland* to those of *France*, are about 7 or 8 to 1. That the People of *Amsterdam* are  $\frac{2}{3}$  of those of *Paris* or *London*, which don't differ, he saith, above a 20th part from one another. That the Value of the Shipping of *Europe* is about 2 Millions of Tuns; of which the *English* have 500000, the *Dutch* 900000, the *French* 100000, the *Hamburgers*, *Danes*, *Swedes*, and *Dantzickers*, have 250000, and *Spain*, *Portugal*, and *Italy*, &c. a-

bout as much. The Value of the Goods exported from *France* into all the Parts is supposed Quadruple to what is sent into *England* alone, and consequently in all about 5000000. What is exported out of *Holland* into *England*, is worth 3000000; and what is exported thence into all the World, is 18000000. The Money yearly raised by the *French King* (in Peace) is about 6  $\frac{1}{2}$  Millions Sterling; and all *Holland* and *Zealand* pay about 2100000 *l.* and all the Provinces together about 3000000. That the People of *England* are about 6000000; their Expence at 7 *l.* per Annum a Head, 42000000. The Rent of the Lands about 8 Millions, and the Profits of the Personal Estate as much. The Profits of all the Labour of the People 26000000. In *Ireland* the People amount to about 12 Hundred Thousand. The Corn spent in *England*, at 5 *s.* per Bushel Wheat, and half a Crown Barley, is worth Ten Millions per Annum. The Navy of *England* (then) required 36000 Men to man it; other Trade of Shipping about 48000 Men to manage it. In *France*, to manage the Shipping Trade, he reckons then but 15000 Men. The whole People of *France* he accounts about 13000000 and an half; and those of *England*, *Scotland*, and *Ireland*, all together, to be 9 Millions and an half. In the King of *England's* Dominions are about 20000 Church-men; and in *France* above 270000. In our whole Dominion above 40000 Seamen, in *France* not above 10000. In *England*, *Scotland*, and *Ireland*, and all other Dominions belonging to us, there was then about 60000 Tun of Shipping; which is worth about 4 Millions and a half of Money. The Sea-Line round *England*, *Scotland* and *Ireland*, and the adjacent Islands, is about 3800 Miles.

In the whole World about 300,000000 of People, and not above 80 Millions with whom the *English* and *Dutch* have Commerce. The Value of the Commodities traded for in the whole, not above 45000000. The Manufactures of *England* in the whole, exported from *England*, amount to about 5000000 per Ann. Lead, Tin, and Coals, 500000 *l.* per Ann. The Value of the *French* Commodities (then) brought into *England*, did not exceed 1200000 *l.* per Ann. The whole Cash of *England* in current Money was then about 6000000 *l.* and at 6000000 of Souls, allowing each to spend 7 *l.* per Ann. the whole Expence will be 42000000; that is, about 800000 *l.* a Week. The Rent of Houses in *England* was then about 4000000 *l.* per Annum.

*Dr. Davenant* also in his Discourses on the publick Revenues and Balance of Trade of *England*, shews the great Use of Political Arithmetick in all the Considerations about the Revenues and the Management of our Trade; he gives some good Reasons why *Sir William Petty's* Numbers above-mentioned are not entirely to be rely'd upon, and therefore advanced others of his own, which are founded upon and supported by the Observations of the ingenious and industrious *Mr. Gregory King*. Some of the Particulars of which, that are most useful, are these: That the Land of *England* is 39 Millions of Acres. The Number of People, according to this Account, is (now) about 5545000 Souls, they increasing about 9000 every Year, Allowances being made for Plagues, &c. Wars, Shipping, and the Plantations. The People



People of *London* he reckons at 530000. Those in the other Cities and Market Towns in *England*, at 870,000, and those in the Villages and Hamlets at 4100000. The yearly Rent of the Land he accounts to be 10,000000. That of the Houses and Buildings 2,000000 *l. per Ann.* The Produce of all kinds of Grain he reckons to be worth 9,075000 *l.* in a Year of moderate Plenty. The Rent of the Corn Land annually 2,000000 *l.* and the neat Produce above 9,000000. The Rent of the Pasture, Meadows, Woods, Forests, Commons, Heaths, &c. 7,000000. The Annual Produce by Cattle, in Butter, Cheefe, and Milk, he thinks, is about 2,500000. The Value of the Wooll yearly shorn, about 2,000000: Of Horses yearly bred, about 250000. Of the Flesh yearly spent as Food, about 3,350000. Of the Tallow and Hides about 600000. Of the Hay yearly consumed by Horses, about 1,300000; of Hay consumed by other Cattle, 1,000000.

Of the Timber yearly felled for Building, 500000 *l.* Of the Wood yearly spent in Firing, &c. about 500,000 *l.* The Land of *England* to its Inhabitants is now about  $7\frac{1}{4}$  Acres *per Head*. The Value of the Wheat, Rye and Barley necessary for the Sustenance of *England* amounts to at least 6,000000 of Pounds Sterling *per An.* The Value of the Woollen Manufacture do's amount to above 2,000000 *l. per An.* The annual Income of *England* on which the whole People live and subsist, and out of which Taxes of all kinds are paid, is now since the War about 43,000000 *l.* That of *France* 81,000000, and that of *Holland* 18,250000 *l. &c.*

The Ingenious Capt. *Halley*, Geometry Professor in *Oxon*, hath made a very exact Estimate of the Degrees of the Mortality of Mankind, drawn from curious Tables of the Births and Burials at the City of *Breslaw*, the Capital of *Silesia*, with an Attempt to ascertain the Price of Annuities upon Lives from thence. This is published in *Philos. Transf. N.* And in the *Miscellanea Curiosa*, Vol. I. From a Table which he hath there calculated he derives the following Uses. 1. To find the Proportion of Men able to bear Arms in any Multitude; which he reckons from 18 to 56 Years old; and accounts about  $\frac{1}{4}$  of the whole. 2. To shew the differing Degrees of *Mortality* (or rather of *Vitality*) in all Ages; by which Means he finds the Odds there is, that any Person of any Age doth not die in a Year's Time, or before he attain such an Age. 3. To shew at what Number of Years, 'tis an even Lay that a Person of any Age shall die; and finds for Instance, that in an even Lay, a Man of 30 Years of Age lives between 27 and 28 Years. 4. To regulate the Price of Insurance upon Lives: And, 5. The Valuation of Annuities on Lives. 6. How to value two or three Lives after the same Manner. And from the whole he makes two very good Observations. 1. How unjustly we complain of the Shortness of our Lives, for it appears, one Half of those that are born don't live above 17 Years. 2. That the Growth and Increase of Mankind is not so much stinted by any Thing in the Nature of the Species, as it is from the curious Difficulty most People make of venturing on the State of Marriage. And therefore Celibacy ought to be every Way discouraged by all wise Govern-

ments; and those who have numerous Families of Children, to be countenanced and encouraged by good Laws, (*i. e.*) such as the *Jus Trium Liberorum*, among the *Romans*, &c. See on this Subject also *Grant's Observations on the Bills of Mortality*; who reckons that there are 39000 square Miles of Land in *England*.

That in *England* and *Wales* there are 4600000 Souls.

That the People of *London* are about 640000; one fourteenth of the People of *England*.

That *England* and *Wales* are about 10.000 Parishes.

In *Dublin* (then) 30000 People.

That there are 25 Millions of Acres in *England* and *Wales*, *viz.* about 4 Acres to every Head.

That but 64 out of 100 of the Children born are living at 6 Years old.

That but 40 of 1000 are alive at 16 Years End.

But 25 out of 100 at 26 Years End.

But 16 out of 100 at 36 Years End.

But 10 out of 100 at 46 Years End.

But 6 out of 100 at 56 Years End.

But 3 out of 100 at 60 Years End.

That *London* doubles it self in about 64 Years.

Sir *William Petty* also in his Discourse about *Duplicate Proportion*, tells us, that 'tis found by Experience, That there are more Persons living between 16 and 26 than of any other Age: And laying down that as a Supposition: He infers, That the Square Roots of every Number of Mens Ages under 16, (whose Root is 4) shew the Proportion of the Probability of such Persons reaching the Age of 70 Years. *v. gr.* 'Tis 4 Times more likely that one of 16 Years of Age lives to be 70, than a Child of 1 Year old. 'Tis thrice as probable, That one of 9 Years lives to 70, as such a new-born Child, &c.

That the Odds is 5 to 4, that one of 25 dies before one of 16 Years.

That 'tis 6 to 5 (still as the Square Roots of the Ages) that one of 36 Years old dies before one of but 25 Years of Age. And so on according to any declining Age to 70; compared with 4.6: Which is nearly the Root of 21, the Law Age.

The above-mentioned Mr. *Halley*, in his Observations on the *Breslaw* Bills of Mortality, saith; That 'tis 80 to 1, a Person of 25 Years of Age doth not die in a Year.

That 'tis  $5\frac{1}{2}$  to one, a Man of 40 lives 7 Years; and that one of 30 may reasonably expect to live 27 or 28 Years.

And so great a Difference is there between the Life of Man at different Ages; that 'tis 100 to 1, one of 20 lives out a Year; and but 38 to 1, that one of 50 doth so. Whence, and from some other Observations, with great Pains he computed the following Table, shewing the Value of Annuities for every 5th Year of Life to the 70th.



A Table of the Value of Annuities.

Age.	Years.	Purchase.
1	10	28
5	13	40
10	13	44
15	13	33
20	12	78
25	12	27
30	11	72
35	11	12
40	10	57
45	9	91
50	9	21
55	8	51
60	7	60
65	6	54
70	5	32

POLLARDS, were formerly a kind of Spurious Coin used in *England*, but these, as also Cro-cards, Staldings, Eagles, Leonomies, and Steepings have been long since disused. See *Matt. West. in Anno 1299. p. 413. 2 Inst. fol. 577. and Plowden, fol. 469.*

POLLUX, a fix'd Star in the *Twins*, of the Second Magnitude, whose Longitude is 108 Degrees 47 Minutes, Latitude 6 Degrees 38 Minutes.

POLYACOUSTICKS, [of πολυ, *much*, or *many*, and ακουσαι, Gr.] are Instruments contrived to Multiply Sounds, as Multiplying-glasses or Polyscopes do Images of Objects.

POLYEDRON, the same with *Polyhedron*.

POLYGON, [of πολυγωνιος of πολυς and γωνια, Gr. *a Corner*] a Term in Geometry, signifying in the general any Figure of many Sides and Angles; tho' no Figure is called by that Name, unless it have more than four or five Sides.

And if all the Sides and Angles be equal, then 'tis called a *Regular Polygon*.

For its Superficial Content, see *Area*.

Every *Polygon* may be divided into as many Triangles as it hath Sides.

If you take a Point, as *a*, any where within the *Polygon*, and from thence draw Lines to every Angle, *a b, a c, a d, &c.* for they shall make as many Triangles as the Figure hath Sides.

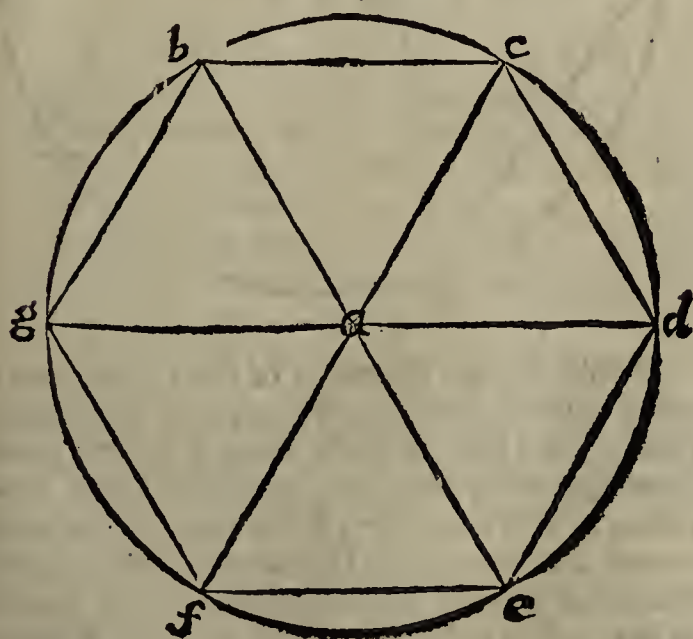
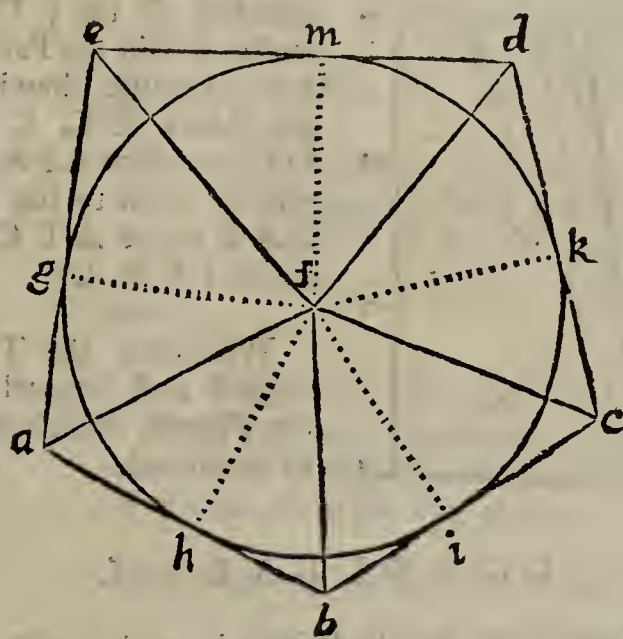
The Angles of any *Polygon* taken together, will make twice as many Right ones, except four, as the Figure hath Sides.

Thus, if the *Polygon* have six Sides, (as in the Figure above) the double of that is 12; from whence take 4, there remains 8. I say, that all the Angles *b, c, d, e, f, g*, of that *Polygon* taken together, are equal to 8 Right Angles.

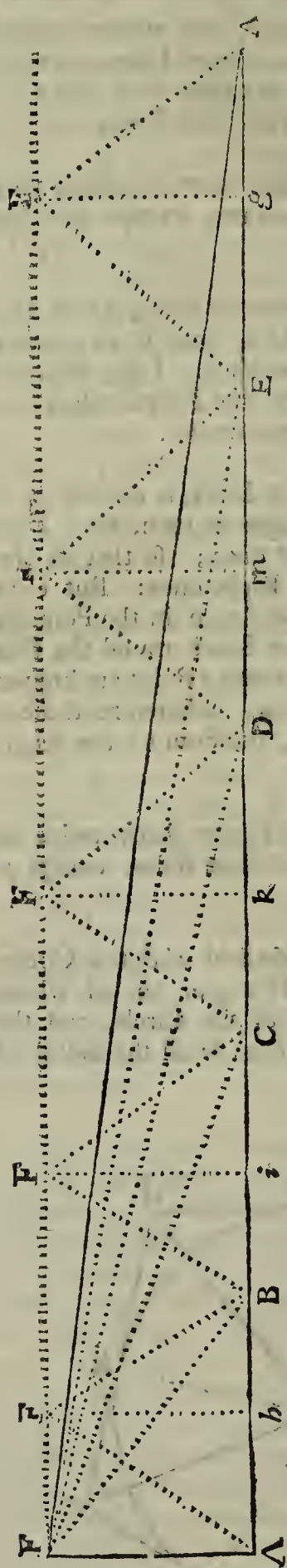
For the *Polygon* having 6 Sides, is divided into 6 *Triangles*; and the 3 Angles of each, by 1. *Eucl.* are equal to 2 Right ones; so that all the Angles together make 12 Right ones: But each of these *Triangles* hath one Angle in the Point *a*, and by it they compleat the Space round the said Point; and all the Angles about a Point are known to be equal to 4 Right ones; wherefore those 4 taken from 12, leave 8, the Sum of the Right Angles of the *Hexagon*.

So that 'tis plain, the Figure hath twice as many Right Angles, as it hath Sides, except 4. *Q. E. D.*

Every *Polygon* circumscribed about a Circle, is equal to a Rectangled Triangle, one of whose Legs shall be the Radius of the Circle, and the other the *Perimeter* (or Sum of all the Sides) of the *Polygon*.







Let the Line  $FA$  be equal to *Radius*  $fb$ , and to it at Right Angles draw the Infinite Line  $ABCD$ , &c. out of which take  $Ab =$  to  $ab$ ,  $bB = bb$ ,  $Bi = bi$ , and  $iC = ic$ , &c. So that the whole Line  $ABCDEA$ , may be equal to the whole *Compass* or *Perimeter* of the *Polygon*  $abcd ea$ .

Also draw  $FF$  parallel to  $AA$ ; so that all the Perpendiculars  $Fb, Fi, Fk$ , &c. may be equal to the *Radius*  $fb, fi$ , &c.

'Tis then plain, That the Triangle  $AFB$  will be equal to the Triangle  $afb$  in the *Polygon*, and the  $\triangle BFC = \triangle bfc$ , also the  $\triangle CFD = \triangle cfd$ , &c. So that all these Triangles taken together, will be equal to all these in the *Polygon*, or to the whole *Polygon*.

But the  $\triangle FAA$  is equal to all the 5 Triangles within the Parallels; because drawing the Lines  $BF, CF, DF$ , &c. The  $\triangle FAB$ , will be equal to the  $\triangle FCB$ ; the  $\triangle FCB = \triangle FCB$ , &c.

Wherefore the Triangle  $FAA$  is equal to the *Polygon*, which was to be proved.

### COROLLARY I.

Hence every *Regular Polygon* is equal to a *Right-angled-Triangle*, one of whose Legs is the *Perimeter* of the *Polygon*, and the other a Perpendicular drawn from the *Centre* to one of the *Sides* of the *Polygon*.

### COROLLARY II.

And every *Polygon* circumscribed about a *Circle*, is bigger than it; and every *Polygon* inscribed, is less than the *Circle*, as is manifest; because the thing containing, is always greater than the thing contained.

### COROLLARY III.

The *Perimeter* of every *Polygon* circumscribed about a *Circle*, is greater than the *Circumference* of that *Circle*; and the *Perimeter* of every *Polygon* inscribed is less.

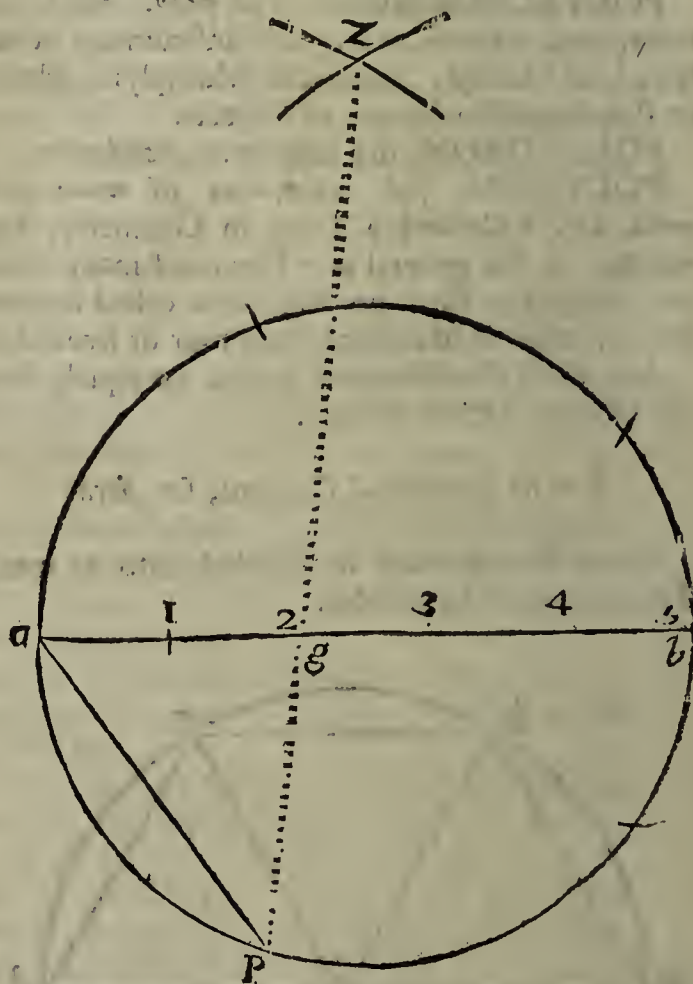
Hence,

A *Circle* is equal to a *Right-Angled Triangle*, whose *Base* is the *Circumference* of the *Circle*, and its *Height* the *Radius* of it.

For this *Triangle* will be lesser than any *Polygon* conscribed, and greater than any inscribed, (because the *Circumference* of the *Circle*, which is the *Base* of the *Triangle*, is greater than the *Compass* of any inscribed;) Therefore it will be equal to the *Circle*. For if this *Triangle* be greater than any thing that is bigger than the *Circle*, and lesser than any thing that is lesser than the *Circle*; it follows, that it must be equal to the *Circle*.

This is called the *Quadrature* or *Squaring* of the *Circle*; that is, to find a *Right-lined Figure* equal to a *Circle*; upon this Supposition, That the *Base* given, is equal to the *Circumference* of the *Circle*; but actually to find a *Right Line* equal to the *Circumference* of a *Circle*, is not yet discovered *Geometrically*.

To inscribe any *Polygon* in a *Circle*.



Divide  $ab$ , the *Diameter* of the *Circle*, into as many equal Parts as the *Polygon* is to have *Sides*; (viz. 5.) and then with the Length of that whole *Diameter* make two *Arks* intersecting each other above, as in  $z$ ; and lay a *Ruler* from  $z$  thro'  $g$ , the second Division of the *Diameter*, which you will find below the Point  $p$ . So is the *Chord*  $ap$  the *Side* of the *Polygon* required; which here is a *Pentagon*.

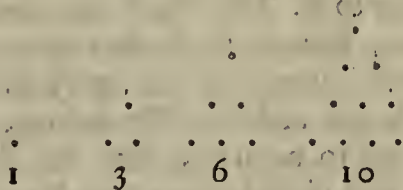
POLYGON,



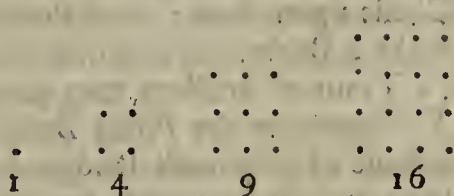
**POLYGON** *Exterior*, in Fortification, is the Distance of one Point of a Bastion from the Point of another, reckoned all round the Work.

**POLYGON** *Interior*, is the Distance between the Centres of any two Bastions, reckon'd all round as before.

**POLYGONAL** *Numbers*, are such as are the Sums or Aggregates of *Series* of Numbers in Arithmetical Progression, beginning with Unity; and so placed, that they represent the Form of a *Polygon*. Thus,



are Triangular Numbers, because they are the Aggregates of a certain Number of Points placed in the Form of Triangles, &c.



are Quadrangular Numbers, &c.

**Line of POLYGONS** [on *French* Sectors] is a Line containing the homologous Sides of the first 9 regular *Polygons*, inscribed in the same Circle, *i. e.* from an equilateral Triangle to a Dodecagon.

**POLYGRAPHY**, [*πολυγραφία* of *πολύ*, *much*, and *γραφη*, Gr. *Writing*] the Art of Writing in various unusual Manners or Cyphers; as also of decyphering the same.

**POLYGRAM**, [*πολύγραμμο*, Gr.] is a Geometrical Figure consisting of many Lines.

**POLYHEDROUS** *Figure*, [of *πολύεδρα*, Gr.] in Geometry, is a Solid contained under or consisting of many Sides; which, if they are *Regular Polygons*, all Similar and Equal, and the Body be inscribable within the Surface of the Sphere, 'tis then called a *Regular Body*. See that Word.

**POLYNOMIAL**, [*πολύνυμος*, Gr.] or *Multinomial Roots*, in Mathematicks, are such as are composed of many Names, Parts, or Members; as,

$$a + b + d + c.$$

In *Philos. Transf.* N. 230. you have a curious Method of raising an Infinite *Multinomial* to any Given Power; or of extracting any Given Root out of such Power: Which was discovered from Sir *Isaac Newton's* Theorem for raising a *Binomial* to any Given Power, or Extracting the Root of the same, by that Ingenious and Excellent Algebraist Mr. *Abr. de Moivre*.

**POLYOPTRON**, [*πολύοπτρον* of *πολύ*, *much*, and *ὀπτρον*, a *Looking-Glass*, of *ὀπτομαι*, Gr. *I see*] a Glass through which Objects appear multiply'd but diminished; it is different from the common multiplying Glasses called *Polyhedra*, both in Structure and *Phænomena*.

**POLYPETALOUS** [*πολυπέταλος* of *πολύ* and *πέταλον*, Gr. a *Leaf*] *Flower*, is the Term in Botany for the Flower of a Plant which consists of

more than Six distinct Flower-leaves set round to form it; and which fall off singly.

**POLYPUS**, [*πολύπους* of *πολύ*, and *πῦς*, Gr. a *Foot*] is a Swelling in the Hollow of the Nostrils; and is Two-fold; either like a Tent, and then it goes by the general Name of *Sarcoma*; or such a one as has a great many distinct Branches or Feet, which extend either to the Outside of the Nose, or the Inside of the Mouth. Their Colour is White, oftentimes Reddish, and sometimes Black and Livid.

Excrescences of this Nature happen not only in the Nostrils, but sometimes in the Heart, and in the Cavities of the thicker Membrane of the Brain. *Blanchard*.

**POLYSCOPES**, [*πολύσκοπον* of *πολύ*, and *σκοπέω*, Gr. *to view*] or *Multiplying Glasses*, are such as represent to the Eye one Object as many.

**POLYSPASTUM**, a Term in Mechanics, the same with the *Trochlea* or *Pully*.

**POLYSPERMÆ** [of *πολύ* and *σπέρμα*, Gr. *Seed*] *Plantæ*, are such Herbs or Plants as have more than Four Seeds succeeding each Flower; and this without any certain Order or Number.

These Mr. *Ray* makes to be a distinct kind of Herbs, calling them *Herbæ semine nudo Polypermæ*: Where by *Semine nudo* he means such Seeds as do not put off, spontaneously, the Integuments or Coverings which they either have, or appear to have, but fall covered with it from the Mother-Plant.

These kind of Herbs he divides into Two sorts.

I. Such as have a *Calyx* or *Perianthium* to their Flower; and this consisting either of,

1. *Three Leaves*; the Flower also being *Tripetalous*, or having but Three Leaves: As, the *Plantago Aquatica*, and the *Sagittaria*, both Water-Plants.

Or where the Flower is *Polypetalous*, and the *Calyx* falling together with the Flower; as in the *Chelidonium minus*; or remaining after the Flower is dropt, as in the *Hepatica mobilis*.

2. *Five Leaves*; in some *Deciduous* with the Flower, as in the *Ranunculus*. In others *Perennial*, as in the *Helleborus niger ferulaceus*; or *Annual*, as in the *Flos Adonis*.

3. *Eight Leaves*; as the *Malva* and *Alcea*.

4. *Ten Leaves*; as the *Carrophylla*, *Fragraria*, *Pentaphyllum*, *Tormentilla*, *Argentina*, *Althæa*, and *Pentaphylloides*.

II. Such as have no *Calyx* or *Perianthium*; as the *Clematis*, *Filipendula*, *Ulmaria*, *Anemone Nemorum*, *Pulsatilla*, &c.

**POMELS**, [in *Heraldry*] are green roundles; so called by *English* Heralds, who express different coloured Roundles by different Names.

**POMIFEROUS** *Herbs*, are (according to Mr. *Ray*,) such as have the largest Fruit of any Plants whatever, and this covered with a thick hard Rind or Bark; by which they are distinguished from the *Bacciferous Herbs*, which only have a thin Skin over the Fruit.

These



These kind of Plants have a naked *Monopetalous* Flower, divided into Five Jaggs or Partitions, and growing on the top of the succeeding Fruit. And these either are,

1. *Capreolate*, or creeping along the Ground, &c. by means of their Tendrils, (*Capreoli*) as the *Cucurbita*, *Melo*, *Cucumis*, *Cepo*, *Belsamina*, *Anguria*, and *Colocynthis*. Or,
2. Without *Capreoli* or Tendrils; as the *Cucurbita Clypeata*, or *Melo-Cepo*, *Clypeiformis*.

POMIFEROUS *Trees*, (see *Trees*) are such as have their Flower on the top of the Fruit; and their Fruit in the Form of an Apple or Pear.



POMMEE, *Pomette*, [in *Heraldry*] as a cross *Pomme* or *Pommette* is a Cross with a Ball or Knob at each end, called also a *Trophee*.

POMPHOLYGODES, [*πομφολυγῶδες*, Gr. of *πομφόλυξ*, Gr.] Urine with many Bubbles upon it; which are frequent, if the Body be puffed up or pained. *Blanchard*.

POMUM *Adami*, is a Protuberance in the Fore-side of the Throat; so called, because 'tis foolishly thought a piece of the Apple stuck in *Adam's* Throat, as part of his Punishment, and hence derived to his Posterity. *Blanchard*.

In Reality 'tis only the Convex part of the first Cartilage of the *Larynx*, called *Scutiformis*. This is greater in Men than in Women.

PONE, is a Writ, whereby a Cause depending in the County Court, or other Inferior Court, is removed into the Common-Pleas.

PONE *per Vadium*, is a Writ to the Sheriff to take Surety of one for his Appearance at a Day assigned.

PONENDIS *in Affisis*, is a Writ founded upon the Statute of *West. 2 cap. 38.* and upon the Statute *Articuli Super Chartas*, cap. 9. Which Statutes shew what Persons Sheriffs ought to impanel upon *Affises* and Juries, and what not.

PONENDUM *in Ballium*, is a Writ commanding a Prisoner to be bailed, in Cases Bailable.

PONENDUM *Sigillum ad exceptionem*, is a Writ whereby the King willeth the Justices, according to the Statute of *West. 2.* to put their Seals to Exceptions laid in by the Defendant against the Plaintiff's Declarations, or against the Evidence, Verdict, or other Proceedings before the Justices.

PONS *Cerebri*, (by some) is a Congeries or Heap of innumerable Filaments divaricated out of the Solider Substance of the Brain, whence all the Nerves take their Rise.

PONTAGE, is a Contribution towards the Maintenance or Re-edifying of Bridges. It may also signifie Toll taken to this Purpose of those that pass over Bridges.

PONTIBUS *Reparandis*, is a Writ directed to the Sheriff, &c. willing him to charge one or more to Repair a Bridge, to whom it belongeth.

PONTON, in Fortification, is a Bridge made of two Boats, at some Distance one from another,

both covered with Planks; as also the Internal Space betwixt them. They have Props and Rails on each side; and the whole Structure ought to be so solid, as to be able to transport the Horse, together with Cannon and Baggage, as well as the Infantry.

PONTON; The late invented *Ponton* is a Boat of *Tin* or rather *Latten*, eight Yards long and two broad, having a large Ring at each Corner: When the Army marches it is laid on a Carriage, and drawn by five Horses. Each Boat hath an *Anchor*, and *Cable*, and *Baulks*, and *Chests* belonging to it. The *Baulks* are seven Yards long and about five or six Inches square: The *Chests* are Boards joined together by Wooden Bars about a Yard broad and four Yards long. When these *Pontons* are to be used, they are flipp'd into the Water, and placed about two Yards asunder, having a strong Rope running through the Rings, which is fastened on each Side the River you would pass over, to a Tree, Stake, &c. The *Baulks* or Beams are laid across the Boats at a due Distance, and the *Chests* upon them; and these are joined close to make a Bridge, over which Foot, Horse, and even a Train of Artillery may pass.

PONT *Volant*, or the *Flying Bridge*, used in Sieges, is made of two small Bridges laid one over another; and so contrived, by the means of Chords and Pulleys placed along the sides of the Under Bridge, that the Upper can be pushed forwards 'till it joins the Place where it is to be fixed; but however the whole Length of both these Bridges must not be above Four or Five Fathom long, lest they should break with the Weight of the Men. These are chiefly used to surprise Out-works or Posts that have but narrow Moats.

POOP of a Ship, is the Floor or Deck over the Round-house or Master's Cabin, being the highest or uppermost part of her *Hull*, *a-stern*.

POPLES, [in *Anatomy*] that Part where the Thigh is joined to the *Tibia*. L.

POPLITEA *Vena*, is the Vein of the Ham, and sometimes reaches down the back of the Leg even to the Heel. This comes from the *Iliacal* Branches of the *Vena Cava*; which, after they descend as low as the Thighs, are called *Crurales*.

POPLITEUS, by some called *Subpopliteus*, is a Muscle of the Leg, which ariseth with a short strong Tendon from the External Head of the Inferior *Appendix* of the *Os Femoris*; from whence descending obliquely over the Juncture, becomes Fleishy, and expanding it self, is so inserted to the superior Part of the *Tibia* internally, immediately below its Superior *Appendix*. This assists the other Muscles in bending the *Tibia*, and also Antagonizeth the *Biceps*, by turning the Foot and Toes outwards when we sit with our Knees bended.

PORES, are small Interstices, Spaces, or Vacuities between the Particles of Matter that constitute every Body, or between certain Aggregates or Combinations of them. Thus, for Instance, those little imperceptible Holes in the Skin, thro' which the Sweat and Vapours insensibly breathe out of the Body, are called *Pores*; and the having of such Holes or *Pores* in any Body, is called *Porosity* or *Porosity*.

The Honourable Mr. *Boyle* has written a Particular *Essay* on the *Porosity* of Bodies; in which he proves, That the most Solid Bodies that are, have some



some kind of *Pores*. And indeed, if they had not, all Bodies would be alike *Specifically* weighty.

**PORES.** Sir *Is. Newton* in his *Opticks* shews, that Bodies are much more *rare* and porous than is commonly believed. Water is 19 times lighter and consequently *rarer* than Gold; and Gold is so rare as very readily and without the least Opposition to transmit the Magnetick *Effluvia*, and easily to admit Quick-silver into its Pores, and to let Water pass through it; for a Concave Sphere of Gold hath, when filled with Water and folder'd up, upon pressing with great Force, let the Water squeeze through it, and stand all over its outside in multitudes of small Drops like Dew, without bursting or cracking the Gold, as he was informed by an Eye-witness. Whence we may conclude, that *Gold hath more Pores than solid Parts*, and by Consequence, that *Water hath above 40 Times more Pores than Parts*. And he that shall find out an Hypothesis to solve how Water can be thus *rare*, and yet not be capable of Compression by Force, may doubtless by the same Hypothesis make Gold and Water, and all other Bodies, as much rarer as he pleases.

So that Light may find a ready Passage thro' transparent Substances, there being open and free Space sufficient for such a Passage. We find that the Magnet transmits its Vertue without any sensible Diminution or Alteration, through all cold Bodies that are not Magnetick, as Gold, Silver, Brass, Glafs, Water, &c. The gravitating Power of the Sun (if you will explain it Mechanically) is transmitted entire through all the vast Planetary Bodies, so that with an equable Force it acts thro' all their Parts, even to their very Centres; *i. e.* according to the Quantity of Matter in each Part. The Rays of Light, let 'em be either Bodies actually coming to us from the Sun, or only Motions or Impressions upon the *Medium*, move in Right-Lines, and are hardly ever, unless by great Chance, reflected back again in the same Right-Line after their Impingence on Objects; and yet we see that Light is transmitted to the greatest Distances thro' Pellucid Bodies, and that in Right-Lines. Now how Bodies should have *Pores* sufficient for these Effects is hard to conceive, but yet not impossible. For Sir *Is. Newton* hath shewn, That the Colours of all Bodies arise from their Particles being of such a determinate Size or Magnitude: (See *Colours*.) Wherefore if we conceive those Particles to be so disposed, as that there is as much of Porosity or Space interspersed between them as the Quantity of these Particles amounts to. And in like Manner, if you suppose these Particles to be composed of others much less, and that these have as much interspersed Vacuity as their Quantity amounts to; and so on till at last you come to solid Particles without any Pores: Then if in any Body there be 3 (for Instance) of these Sizes of Particles, and that the last be of the *solid* or least Sort; that Body will have 7 Times as much Vacuity as Solid Matter. If you suppose 4 such Degrees or Sizes of Particles, and that the last and least be solid; the Body will have 15 Times as much *Pores* as *Solidity*. If you imagine any Body to have 5 such Degrees or Sizes of Particles, it will have 31 Times as much Space as *Solidity* interspersed: And if it have 6 such Sizes of Particles as before, it will have 63 Times as much Vacuity as Solid Matter, and so on. And perhaps in the

wonderful Conformation and Fabrick of Natural Bodies there may be other Proportions of Space to Matter to us wholly unknown, whence 'tis possible there may be yet far greater Quantities of Vacuity interspersed in Bodies.

**PORIME**, (Gr. *ποριμ*) in Geometry, is a Theorem or Proposition so easie to be demonstrated, that 'tis almost self-evident; as, *That a Chord is all of it within the Circle*. And on the contrary they call that an *Aporime*, which is so difficult as to be almost impossible to be demonstrated; as the *Quadrature of the Circle* is now, and as the Squaring of any Assigned Portion of *Hippocrates* his Lunes was, 'till a little while ago.

**PORISME**, *Proclus* and *Pappus* define this Geometrical Term to signify a kind of Theorem, in the form of a Corollary, which is dependent upon, or deduced from some other Theorem already demonstrated. And 'tis commonly used to signify some General Theorem, which is discovered from finding out some Geometrical Place: As, for Instance, if a Man hath found out by Algebra, or any other Method how to Construct a *Local Problem*; and from that Place so constructed and demonstrated, hath deduced some General Theorem, that Theorem is by the Geometrick Writers called a *Porism*. Of these *Porisms*, Mr. *Ozanam*, in his *French Mathematick Dictionary*, gives many useful Instances; which see.

**PORISTICK Method**, in Mathematicks, is that which determines *when, by what way, and how many different ways*, a Problem may be resolved.

**POROCELE**, is a Rupture proceeding from Callous Matter, or the Stone. *Blanchard*.

**POROTICA**, are Medicines, which, by drying, thickening, and astringent Qualities, turn part of the Nourishment into Brawny, Callous, Matter. *Blanchard*.

**POROSITY**. See *Pores*.

**PORTA**, the same with *Vena Portæ*.

**PORT the Helm**, a Sea-Term, signifying to put the Helm to the Left or *Larboard* Side of the Ship; but however they never say *Larboard the Helm*, but always *Port it*; tho' they say *Starboard the Helm*, when it is to be put to the Right side of the Ship. A Ship is said to *Heel a-port*, when she swims not upright, but leans to the Left side. The Word

**PORT**, also signifies a Haven or Harbour; as also the Holes in a Ship's side thro' which her Great Guns are put out.

**PORT-Last**, the same as the *Gun-wale* of a Ship; therefore they say a *Yard is down a Port-Last*, when it lies down on the Deck.

**PORTA or Vena Portæ**: Dr. *Keil* in *Animal Secretion*, p. 36, 37, &c. thinks that he hath found out the true Use of this *Vein*, (of which you have a large Description in the Vol. I. under *Vena Portæ*) which is, that the Bile being to be mixed with the Chyle as it comes out of the Stomach into the *Duodenum*, could no where be so conveniently secreted from the Blood, as where the Liver is placed: But if all the Branches of the *Cæliack Artery* carried all the Blood to the Liver, from which the Gall was to be separated; it is evident, considering the nearness of the Liver to the Heart, and the intestine Motion of the Blood, that so viscid a Secretion as the Gall is, could never have been formed in the Blood, and consequently could never



have been secreted by any Gland in that Place. In this Case Nature is forced to alter her constant Method of sending the Blood to all the Parts of the Body by the Arteries. Here she forms a *Vein*, (which is no Branch of the *Cava*, as all the others are) and by it she sends the Blood from the Branches of the Mesenterick and Cæliack Arteries, (after it hath passed thro' all the Intestines, Stomach, Spleen, Gall, and Pancreas) to the Liver. By this extraordinary Contrivance the Blood is brought a great way about before it arrives at the Liver; and its Celerity is extremely diminished; so that all the Corpuscles which are to form the Bile, may have sufficient Time to attract one another, and unite before they come to the secreting Vessel. And thus, saith he, have we found out the true Use of the *Porta*; which he confirms afterwards, by shewing what Nature doth further in Prosecution of the same Design; in increasing the Cavities of all the Arteries as they divide, and that as the Trunk of the Mesenterick Artery bears a lesser Proportion to its Branches than the *Aorta* does to its Branches; so the Branches of the Mesenterick Artery are likewise less in Proportion to their *Conjugate Veins* than the *Aorta* is to the *Vena Cava*. The descending Trunk of the *Aorta* below the Emulgents is to the *Vena Cava* at the same Place, as 324 is to 441. But a Branch of the Mesenterick Artery is to its corresponding Branch of the *Porta* as 9 to 25: And therefore the Blood in the Branches of the *Porta* moves above 177 Times Slower than it does in the Trunk of the Mesenterick Artery, and then only upon the Account of the Increase of the Diameters of the Vessels. So necessary is it to abate the Rapid Intestine Motion of the Blood, which would otherwise hinder the Coalescence of the Particles for the Formation of the Gall.

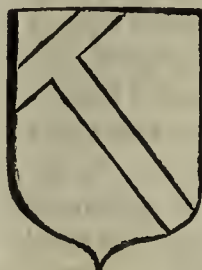
**PORTABLE Barometer**, was first invented by the Honourable Mr. Boyle, and was effected by making the Torricellian Experiment in a long Glass Tube, sealed at the Top, and bent near the bottom up again, parallel to the longer Leg. For by this means the Quick-silver in the open and shorter Leg, supplied the Place of the stagnant Mercury in the Basen or Cistern. The Instrument was all of one piece, and might easily be carried from Place to Place without spilling the Mercury. By which means, Observations of the Weight of the Atmosphere might be readily made on the Tops of Hills, Bottoms of Mines, &c.

But this open Tube could not be carried about with so much Ease and Safety as those *Portable Barometers* which are now in Use, and which was made by Mr. John Patrick, Torricellian Operator in the Old Bailey, with very great Exactness and Neatness: For in these there is an Invention to screw the Mercury quite up to the Sealed end of the Tube, by which means it will not swag up and down in the Carriage, and so by its great Weight endanger the breaking of the Tube. See *Barometer*.

**PORTAIL**, [in *Architecture*] the Face or Frontispiece of a Church viewed on the Side where the great Door is.

**PORTAL**, [in *Architecture*] a little square Corner of a Room cut off from the rest of the Room by the Wainscot, common in ancient Build-

ings but now despised; also a little Gate or *Portella*, where there are 2 Gates of a different Bigness.



**PORTATE**, [in *Heraldry*] as a *cross Portate* is a cross that does not stand upright, as crosses generally do; but lies athwart the Escutcheon, in Bend, or as if it were carried on a Man's Shoulders.

**PORTCULLICE**, *Herse*, or *Sarazine*, in Fortification, signifie several great Pieces of Wood laid or joined across one another like an Harrow, and at the Bottom it is pointed at the end of each Bar with Iron. These formerly used to hang over the Gate-ways of Fortified Places, to be ready to let down in Case of a Surprise, when the Enemy should come so soon, as that there is no Time to shut up the Gates. But now a-days the *Orgues* are more generally used, as being found to be much better. See *Orgues*.

**PORT VENT** [in an *Organ*] is a wooden Pipe, well closed, which serves to convey the Wind from the Bellows to the sound Board of the Organ.

**PORT Ropes** [in a *Ship*] are those that are used to hale up the Port of the Ordnance.

**PORTFIRE**, is a Composition of Metal, Powder, Sulphur and Salt-Petre drove into a Case of Paper, but not very hard; 'tis about 9 or 10 Inches long, and is used to fire Guns and Mortars instead of Match.

**PORTICO**, or *Porch*, in Architecture, is a long Place cover'd either with a vaulted Roof, or an even Floor, supported by Pillars. But this Word may be applied to signifie all manner of Dispositions of Columns in a Gallery.

**PORTIFORUM**, was formerly an Ensign or Banner, which was provided in all Cathedral and most Parochial Churches, to be solemnly carried in the Front of any Procession.

**PORTIONER**, where a Parsonage is served sometimes by two, or sometimes by three Ministers alternately. The Ministers are called *Portioners*, because they have but their Portion, or Proportion of Tythes or Profits of the Living.

**PORTMANNIMOTE**, sometimes hath been used for *Portmote*, which see.

**PORTMOTE**, signifies a Court kept in Haven Towns, as *Swainmote* in the Forest, and is called the *Portmote Court*.

**PORTMOTE**, is a Convention or Meeting of the Inhabitants of a Port of a Burgh, in which some Customary Duties were anciently paid to the Lord of the Fee.

**PORT-NAILS**, are such Nails as are used to fasten the Hinges to the Ports of the Ships.

**PORTOISE**, aboard a Ship, is the same with *Portlast*, or the *Gunwale*; and as they say *the Yard is down a Portlast*, when it lies down on the Deck, so for a Ship to *ride a Portoise*, is to ride with her Yards a *Portlast*, or struck down on the Deck.

**PORTRAITS**, is the Painters Word for Pictures of Men and Women (either Heads, or greater Lengths) drawn from the Life; and the Word is used to distinguish this kind of Face-Painting (as it is often called) from History-Painting.



PORTREVE, is the Title for the Chief Magistrate in some Sea-Coast Towns: And *Cambden* in his *Brit. faith*, the Chief Magistrate of *London* was so called in *William* the Conqueror's Time, as appears by a Charter of his to this City. In *Richard* the First's Time, the City was governed by two Bailiffs appointed by the King; but presently after King *John* granted them a Mayor for their yearly Magistrate.

PORTSOKNE, the *Soke* or Liberties of any Port; *i. e.* City or Town.

PORUS *Bilarius*, or *Meatus Hepaticus*, is a Pipe or Channel passing directly from the Liver to the *Ductus Communis*, and which transmits the Bile from the Liver, by the Intervention of some small Glandules. Within the Liver, its Trunk and Branches are invested with a double Coat: A *Proper* one which it retains also without the Liver; and another common to it and the *Porta*, called *Capsula Communis*, which it hath from the Membrane of the Liver. In this common Coat, this *Porus* and the *Porta* are so closely enwrapped, that at first they appear but one Vessel; but if you hold them up to the Light, you will discover Vessels of two Colours; and then you may dexterously rip up the *Capsula*, and so lay them open. Its Roots within the Liver are equally divided with those of the *Porta* every where, except in that little Space where the Roots of the *Vesica* are spread on the Right side of the Liver; and they are both larger and more numerous than those of the *Vesica*, drawing Choler from all Parts of the Liver almost. And this *Porus Bilarius* seems to be a more necessary Part than the Gall-Bladder, or *Vesica*; because in many Creatures, as Red and Fallow Deer, Horses, &c. the *Vesica* is wanting, but none want this. Without the Liver, 'tis as wide again as the *Meatus Cysticus*, with which it joins at two Inches Distance from the Liver; and so both make up the *Ductus Choledochus Communis*. The *Porus* hath no Valve in its whole Progress; only the *Ductus Communis*, at its Entrance into the Intestines, having pierced the Outer Coat, passes between *that* and the Middlemost Coat, for about the 12th part of an Inch; and then piercing *that* also, marches down farther between it and the Inner Coat of the Gut, for about half an Inch, and at last opens with a round Mouth into the Intestine: So that this Oblique Insertion (like that of the Ureters into the Urinary Bladder) serves instead of a Valve, to hinder any thing from Regurgitating out of the Guts into this Duct: And this is farther prevented also by the flaggy, loose Constitution of the Inner Tunick of the Guts; which, when any thing would enter, the Mouth of the *Porus* claps close upon it, and stops it. There are no *Anastomoses* between the Roots of this Duct and those of the *Porta*, as have been often said; For the Extreme Capillary Twigs of the *Porus* terminate in the *Parenchyma* of the Liver, out of whose Glandules they imbibe the Choler, there separated from the Blood.



POSE', [in *Heraldry*] signifies a Lion, Horse, or other Beast, with all 4 Feet on the Ground to intimate he is not in a moving Posture.

POSITION, or *Site*, is an Affection of Place, and expresses the manner of any Body's being in a Place: This therefore is not *Place*, nor indeed hath it any Quantity; as Sir *Is. Newton* well observes in *Princip. Mathem.* p. 6.

POSITION, [in *Architecture*] the Situation of a Building in respect to the Points of the Horizon.

POSITION, [in *Astronomy*] the Position of the Sphere is either Right, Parallel, or Oblique, whence arises the inequality of our Days, difference of Seasons, &c.

Circles of POSITION, [in *Astronomy*] are six great Circles which pass thro' the Intersection of the Meridian and Horizon, and divide the Equator into 12 equal Parts.

POSITION, or the *Rule of Position*, otherwise called the *Rule of Falshood*, is a Rule in Arithmetick, wherein any Number is taken to work the Question by, instead of the Number sought; and so by the Error or Errors found, we find the Number required.

This *Rule of False Position* is of two kinds, *viz.* *Single* and *Double*.

POSITION *Single*, is when there happens in the Proposition some Partition of Numbers into Parts Proportional; and then at one Operation the Question may be resolved, by this Rule.

Imagine a Number at pleasure, and work therewith according to the Tenor of the Question, as if it were the true Number; and what Proportion there is between the False Conclusion and the False Position, such Proportion hath the Given Number to the Number sought: Therefore the Number found by Argumentation shall be the first Term of the *Rule of Three*, and the Number supposed shall be the second Term, and the Given Number shall be the third Term.

*Example.*

Three Men, *A*, *B*, and *C*, consent to buy a Ship for 220 *l.* So that *B*, must pay twice as much as *A*, and *C*, four times as much as *B*. How much must each Man pay?

*Answer.* Suppose *A.* paid 8 *l.* then (according to the Question) *B.* must pay 16 *l.* and *C.* four times as much, *i. e.* 64 *l.* But all these Numbers added together, make no more than 88 *l.* whereas there should be 220 *l.* Yet by the help of this Number, I say, If 88 *l.* come of 8 *l.* of what comes 220 *l.* wherein the Work is gain'd 20 *l.* for the Part of *A.* Then *B.* must pay 40 *l.* and *C.* 160; which added together, give 220 *l.* the Number propounded.

	<i>Position false.</i>	<i>Conclus. true.</i>
<i>Position</i>	8 88 <i>l.</i> : 8 <i>l.</i> :: 220 <i>l.</i> : 20 <i>l.</i> <i>A</i>	
<i>Double</i>	16	40 <i>B.</i>
<i>Quadruple</i>	64	160 <i>C.</i>
	<hr/> 88	<hr/> 220 Proof.

If there be a Fraction or Fractions in the Question, then for more Facility in Proceeding take such



such a Number for the *Position* as may be equally parted by the Parts express'd in the Question.

In Questions propounded, it happens sometimes that a Number stands unalterable by the Fractions given, and so may be subtracted from the Sum given, and set by 'till the Operation be made with the rest, and then restored again.

**POSITION Double**, is when there can be no partition in the Numbers to make a Proportion: Therefore you must make a Supposition twice, proceeding therein according to the Tenor of the Question; and if either of the supposed Numbers happens to solve the Proposition, the Work is done; but if not, observe the Errors, and whether they be greater or lesser than the Resolution required, and mark the Errors accordingly, with the Signs  $+$  or  $-$

Then multiply contrariwise the one *Position* by the other Error; and if the Errors be both too great, or both too little, subtract the one Product from the other, and the one Error from the other, and divide the Difference of the Products by the Difference of the Errors.

But if the Errors be unlike, as the one  $+$ , and the other  $-$ , add the Products, and divide the Sum thereof by the Sum of the Errors added together: For the Proportion of the Errors is the same with the proportion of the Excesses or Defects of the Numbers supposed, to the Numbers sought.

#### Example.

Two Men, *A.* and *B.* discoursing of their Money; *A.* says to *B.* *If I had two of your Pieces, I should have twice as many as you have*; to which *B.* replies, *If I had two of yours, I should have just as many as you have*: How many had each?

Suppose *A.* had 16, to which 2 being added makes 18, which is twice 9; but having taken 2 from thence, it must be by that Supposition that *B.* had 11: Wherefore 2 taken from 16, and added to 11, makes 13 for *B.* and *A.* 14. But they should be equal; therefore the Position is erroneous, and the Error too much by 1.

Again, Suppose *A.* had 20, then  $20 + 2 = 22$  that is twice 11; but from thence 2 being taken, *B.* must have 13. Now 2 from 20, and put to 13 gives 15 for *B.* and leaves 18 for *A.* which is not equal; therefore the Error again is 3 too much.

Then multiplying 16 the first Position, by 3 the second Error, and also 20 the second Position by 1 the first Error; the Product 20 is taken from the Product 48, (because the Errors are both  $+$  and the remainder 28 is the Dividend; and the lesser Error 1 subtracted from the greater Error 3, leaves 2 for the Divisor; the Quotient of which Division will be 14, the Number sought for *A.* and then by consequence *B.* must have 10: For 2 taken from 10, and added to 14, make 16 = twice 8; 2 taken from 14, and put to 10, makes 12 both alike.

$$\begin{array}{r} \text{First} \qquad \qquad \text{Second} \\ \text{Position } 16 \times 20 \text{ Position} \\ \hline \text{Error } 1+ \quad 3+ \text{Error.} \\ \hline 20 \qquad 48 \end{array}$$

$$\begin{array}{r} \text{Products } 48 - 20 = 28 \quad (14 \text{ A.} \\ \text{Errors } 3 - 1 = 2 \quad (10 \text{ B.} \end{array}$$

Proof.

$$\begin{array}{r} 14 + 2 = 16 \\ 10 - 2 = 8 \end{array} \left. \begin{array}{l} \\ \end{array} \right\} \text{half.}$$

$$\begin{array}{r} 14 - 2 = 12 \\ 10 + 2 = 12 \end{array} \left. \begin{array}{l} \\ \end{array} \right\} \text{equal.}$$

If the Suppositions had been 12 and 10, the Errors being both  $-$ , the Operation would have stood thus, as before, because the Errors are alike.

$$\begin{array}{r} \text{First} \qquad \qquad \text{Second} \\ \text{Position } 12 \times 10 \text{ Position.} \\ \hline \text{Error } 1- \quad 2- \text{Error.} \\ \hline 10 \qquad 24 \end{array}$$

$$\begin{array}{r} \text{Products } 24 - 10 = 14 \quad (14 \text{ A.} \\ \text{Error } 2 - 1 = 1 \quad (10 \text{ B.} \end{array}$$

But if the Suppositions are 20 and 10, then the Errors being found unlike; the Sum of the Products must be the Dividend, and the Sum of the Errors the Divisor.

$$\begin{array}{r} \text{First} \qquad \qquad \text{Second} \\ \text{Position } 20 \times 10 \text{ Position.} \\ \hline \text{Error } 3+ \quad 2- \text{Error.} \\ \hline 30 \qquad 40 \end{array}$$

$$\begin{array}{r} \text{Product } 30 + 40 = 70 \quad (14 \text{ A.} \\ \text{Errors } 3 + 2 = 5 \quad (10 \text{ B.} \end{array}$$

*Note*, 1. That as well in the *Single* as in the *Double Rule of Position*, tho' the Number supposed be never so false, a Resolution may be had thereby: Yet for more Ease in the Operation, suppose a Number that may be parted equally into so many Parts as are necessary to the Resolution of the Question.

2. Let the Second *Position* be always *Homogeneous*, or of the same kind with the first; that is, belong both to one Man, one Thing, &c.

3. If both the Errors be equal in Numbers, and yet their Signs unlike, half of both the *Positions* is the Sum desired.

4. All the Propositions resolved by *Single Position*, will be resolved by *Double Position*.

**POSITIVE** Degree of Comparison in Grammar, is that which signifies the Thing simply and absolutely, without comparing it with others; it belongs only to *Adjectives*.

**POSITIVE** Levity. See *Levity*.

**POSITIVE** Quantities in Algebra, are such as are of a Real and Affirmative Nature, and either have, or are supposed to have the Affirmative or Positive Sign  $+$  before them, and 'tis always used in opposition to the *Negative Quantities*,



ties, which are defective, and have this Sign — before them.

**POSSE Comitatus**, a Term in Law, signifying the Aid and Attendance of all Knights, Gentlemen, Yeomen, Labourers, Servants, Apprentices; and all others, above the Age of Fifteen Years within the County; except Women, Ecclesiastical Persons, and such as are decrepid, or labour of an Infirmary: And the Statute of 2 H. 3 cap. 8. says, *That Persons able to Travel, shall be assistant in this Service*, which is used where a Possession is kept upon a Forcible Entry, or any Force of Rescue used, contrary to the Command of the King's Writ, or in opposition to the Execution of Justice.

**POSSESSION**, in a Legal Sense, is taken twofold, *Actual* and *in Law*: *Actual Possession* is, when a Man actually enters into Lands and Tenements to him descended. *Possession in Law*, is when Lands or Tenements are descended to a Man, and he hath not as yet actually entered into them. As for Example,

Before or until an Office be found of Lands Escheated by an Attainder, the King hath only a *Possession in Law*, and not in *Deed*: There is also a Unity of *Possession*, which the *Civilians* call *Consolidationem*. If the Lord purchase the Tenancy held by *Heriot Service*, then the *Heriot* is extinct by Unity of *Possession*; that is, because the Seigniorship and the Tenancy are now in one Man's *Possession*.

**POSSESSIVES**, in Grammar, are such *Adjectives* as signify the Possession of, or Property in some Thing.

**POST**, in the Art Military, is used for any sort of Ground or Place, whether fortified or not, where a Body of Men can make a Stand, fortify themselves, or be in a Condition to fight an Enemy; and therefore they say the *Post* was relieved; the *Post* was quitted, the *Post* was taken Sword in Hand, &c. A Spot of Ground seized by a Party to secure the Front of an Army and to cover the Posts that are behind; they call an *Advanced Post*: And the *Advance Guard* or the *Right* of 2 Lines of an Army, &c. they call the *Post of Honour*.

**POSTEA**, in Law, is the Return of the Proceeding by *Nisi prius*, into the Court of *Common-Pleas*, after a Verdict, and there afterwards Recorded:

**POST-Brachiale**, vid: *Metacarpus*.

**POST Diem**, is the Return of a Writ after the Day assigned; for which the *Custos Brevium* hath four Pence, whereas he hath nothing if it be return'd at the Day; sometimes it is taken for the Fee it self.

**POST Disseisin**, is a Writ given by the Statute of *Westminst.* 2. cap. 26. and lies for him that having recovered Lands or Tenements by *Præcipe quod reddat* upon the Default or Reddition; is again disseised by the former Disseisor.

**POST Fine**, in Law; is a Duty belonging to the King, for a Fine, formerly acknowledged before him in his Court, which is paid by the Cognisee, after the same is fully passed, and all things performed touching the same; the Rate thereof is so much, and half so much as was paid to the King for the Fine, and is collected by the Sheriff of the County, where the Land, &c. lies whereof the Fine was levied, to be answered by him into the Exchequer.

**POST Terme**, is a Return of a Writ, not only after the Day assigned for the Return thereof, but after the *Term* also; for which, the *Custos brevium* takes the Fee of Twenty Pence; sometimes also it is taken for the Fee it self.

**POSTERN**, in Fortification, is a false Door usually made in the Angle of the *Flank*, and of the *Curtain*, or near the *Orillon* for private Sal-lies.

**POSTICUM**, is the *Postern Gate*, or *Back-Door* of any Fabrick.

**POSTS** [in *Sculpture*, &c.] are Ornaments formed after the Manner of Rolls or Wreathings, so called because they seem to run one after another.

**POSTERIORITY** [in *Law*] a Term in Comparison and relation in Tenure, which is opposite to Priority.

**POSTICK**, *Postique* [with *Architects*] a Term used of an Ornament of Sculpture, when it is added after the Work it self is finished.

**POSTNATI**, are such as were born in *Scotland* after the Descent of that Crown to K. James I. And it was resolved in the 7th Year of that King's Reign by all the Judges, that such Persons are *no Aliens* in *England*. But the *Ante-Nati* or such as were born in *Scotland* before that Time, were Aliens as to the Time of their Birth.

**POSTULATES**, or *Demands* in *Mathematicks*, &c. are such easy and self-evident Suppositions as need no Explication or Illustration to render them Intelligible. As,

*That a Right Line may be drawn from one Point to another.*

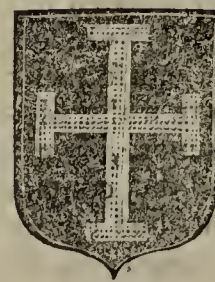
*That a Circle may be described on any Centre given, of any Magnitude, &c.*

**POSTULATION**, (in the Law) is made upon the Unanimous Voting of any Person to a Dignity or Office, of which he is not capable by the Ordinary Canons or Statutes, without special Dispensation.

**POTANS**, or *Potence*, a Part of a Watch; see under *Balance*.



**POTANCE CRAMPONNE** [in *Heraldry*] is a Cross in the Form represented in the Escutcheon.



**POTENT**, or *Potence*, the Term for a Cross in Heraldry, formed into this Figure.

He beareth *Sable*, a *Cross Potent*, Or, by the Name of *Aleyn*.

This Form represents the upper end of a Crutch; for anciently Crutches were called *Potents*.

**POTENT**, *Counter Potent*, a Term in Heraldry: See *Vairy Copy*.

**POTENTIAL Coldness**, is a Relative Quality which some Drugs, Simples, or Compound Medicines are supposed to be endowed with: And therefore you will find frequently in some Old Books, or in the Writings of such as follow the Old Physicians, that such a Plant or Drug, is cold in the 2d or 3d Degree: The meaning of which, is,



not that such a Plant is actually cold to the Touch, but that it is Cold in its Effects and Operations, if taken inwardly. And whenever such an Effect doth follow the taking of such Medicine, Mr. Boyle thus accounts for it according to the Mechanical Philosophy, viz. That this Body, which they call *Potentially Cold*, is made up of *Corpuscles* of such a Size, Shape, &c. that being disjoined and resolved by the *Menstruum* of the Stomach, or the Fluids it may elsewhere meet with, they do so intimately associate themselves with the small parts of the Blood and other Liquors, as by clogging and impeding them to lessen their wonted Agitation; and perhaps also to make them act in a peculiar way, as well as less briskly on the Nervous and Fibrous parts of the Body: The Perception of which *Imminution*, or perhaps *Change* of Motion in the Organs of Feeling, is that, which being referred to the Body that produced it, is called *Potential Coldness*.

Hence, if it be supposed that in Agues some Morbifick Matter of a viscus, or not easily dissolvable Texture, be harboured in some part of the Body, and requires such a Time to be made fluid and resolvable, which is an *Hypothesis* generally received, the Cold Fits in these Diseases, will be plausibly accounted for.

Also the Shiverings and Cold arising from the taking of most Poisons, may hence be solved; and that lesser Degree of it which seizes *Hypochondriack* and *Hysterical* Persons.

POTENTIAL Mood in Grammar, is the same in form with the *Subjunctive*; but differs in this that it hath always implied in it, either *Possum*, *Volo*, or *Debeo*; as *Roget Quis*, that is, *Rogare potest*, a Man may ask. 'Tis sometimes called, The *Permissive* Mood, because it implies often a Permission or Concession to do a Thing: As,

*Habeat, valeat, vivat cum illa.* Terent.

POUDER Chests, are Boards joined in Form of a Triangle, fill'd with Gun-Powder, Pebble-Stones, &c. which they put fire to when a Ship is boarded by an Enemy, which soon clear all before them.

POUDERINGS [with *Architects*] Devices which serve to fill up vacant Spaces in carved Works, as also in Escutcheons, Writings, &c.

POUND *Libra*, contains 12 Ounces; and tho' now it signify 20s. when applied to Money, which is but the 3d Part of a Pound in Weight, yet it is because 20s. did heretofore (with us) weigh a full Pound Troy or 12 Ounces, each of these Ounces contained so many *Solidi* or Shillings, and so many *Denarii* or Pence, as they who govern'd the Money Matters thought fit, sometimes more, sometimes fewer. The old *Saxon* Pound did contain 48 Shillings, and each Shilling contained 5 d. so that the *Libra Anglo-Saxonica* contained 240 d. When the Pound was reduced 'tis hard to tell exactly, but in *William the Conqueror's* Time it contained 20s. sometimes the Pound was composed of 12 Ounces or *Ora*, and then the *Ora* was 20 d. and sometimes of 15 Ounces or *Ora*, and then the *Ora* was 16 d. But tho' either of these may be taken for the *Shilling*, yet generally it was 20 d. and this was the Value of the Ounce in the *Libra Denariorum* and the *Libra Sterlingorum*, which are the same. See *Chro. Pretiosum*.

POUR *faire proclamee*, que null inject fines ou ordures en fosses, ou rivières pres Cityes, &c. is a Writ directed to the Mayor, Sheriff, or Bailiff of a City or Town, commanding them to proclaim, That none cast Filth into the Ditches or Places near adjoining, and if any be cast already, to remove it.

POUR Party, is a Term in Law, contrary to *pro indiviso*; for to make *Pour party*, is to divide and sever the Lands that fall to *Parceners*, which before Partition they held jointly, and *pro indiviso*.

POUR *Seisir Terres la femme que tient en Dower*, &c. was a Writ whereby the King seized upon the Land, which the Wife of his Tenant that held *in Capite*, deceased, hath for her Dowry, if she Married without his Leave; and is grounded upon the Statute of the King's Prerogative.

POUR *Suivant*, signifies the King's Messenger attending upon him in his Wars, or at the Council Table, Exchequer, in his Court, or his Chamber, to be sent upon any Occasion or Message; as for the Apprehending of a Person Accused, or Suspected of any Offence: Those that be used in Martial Causes, are called *Pursuivants at Arms*, others are used upon Messages in times of Peace, and especially in Matters touching Jurisdiction.

POURVEYANCE, is the providing Corn, Fuel, Victuals, and other Necessaries for the King's House.

POURVEYOR, signifies an Officer of the King or Queen, or other great Personage, that provideth Corn and other Victuals for their House.

POWCHES, so the Seamen call small Bulkheads made in the Hold of a Ship, to stow Corn, Goods, or the like, that it do not shoot from one side to the other.

POWER of the County, See *Posse Comitatus* in Vol. I.

POWERS in *Algebra*, are Numbers arising from the Squaring or Multiplication of any Number or Quantity by it self, and then that Product by the Root or first Number again; and this Third Product by the Root again; and so on *ad Infinitum*; as 2, 4, 8, 16, 32, 64, 128, 256, &c. Where 2 is called the Root or First Power, 4 is the Square or Second Power, 8 is the Cube or Third Power, 16 is the Biquadrate or Fourth Power, &c. And these Powers in Letters or Species, are expressed by repeating the Root as often as the Index of the Power expresses, thus; *a* is the Root or First Power, *a a* the Square or Second Power, *a a a* the Cube, *a a a a* the Biquadrate or Fourth Power. And to avoid the tediousness of repeating the Root so often when the Powers are high, we only put down the Root with the Index of the Power over it, thus: *a*<sup>9</sup>, that is the ninth Power of *a*; *b*<sup>16</sup>, *b*<sup>94</sup>, are the sixteenth or the ninety fourth Powers of *b*.

POWERS, *Mechanicks*, are the Six Mechanical Faculties; the Ballance, the Leaver, the Wheel, the Pulley, the Wedge, and the Screw; which are usually stiled the Six *Mechanick Powers*. The Force also or Strength brought for the moving of any Weight by any Engine, is called the *Power*. And the design of *Mechanicks*, is to teach Men how to add such a fitting Supplement to the Power, as that it may move any Weight required, with facility and cheapness, and in as little room as may be.

POWERS



POWERS *Mechanick*, of these there are 5 usually accounted, the *Lever*, the *Balance*, the *Wedge*, or inclined *Plane*, *Screw* and the *Pulley*. About these Powers (the Nature of which you will see under those Words, or the *Latin* Names) there are some Universal Laws agreed on, which it would be well for Mechanicks, Engine-Makers, &c. to have in Readiness in their Minds, lest some such impossible Whims as the *Perpetual Motion*, &c. should get Possession of their Heads.

## R U L E I.

*The moving Forces or Powers are to the Weight to be moved, reciprocally, as the Space passed by the Weight, is to that passed by the Power.*

Thus in the Windlace *Axis in Petrochio*, &c. the Circle or Part of such a Periphery, which the Power moves, is to the Periphery of the Axis of the Cylinder reciprocally as the Weight to the Power.

And in Pulleys 'tis plain that the Ropes are shortened in Proportion to the Elevation of the Weights.

## R U L E II.

*The Power or moving Force, and the Weight are reciprocally proportional to their Velocities.*

## R U L E III.

*The same Force which can lift (ex. gr.) 100 lb. the height of 2 Feet; will raise 200 lb. the height but of one Foot.*

POWERS of *Lines*, or Quantities are their Squares, Cubes, &c. or other Multiplications of the Parts into the whole, or of one Part into another.

POYNING's Law, is an Act of Parliament made in *Ireland* by Hen. 7. and so called, because Sir Edward Poyning was Lieutenant there, when it was made; whereby all the Statutes in *England* were made of Force in *Ireland*, which before that time were not, neither are any now in force there which were made in *England* since that time.

PRACTICE in Arithmetick, is a Rule which expeditiously and commodiously answers Questions in the *Rule of Three*, when the first Term is 1, or Unity, and 'tis so called from its readiness in the *Practice* of Trade and Merchandise.

Of this Rule there are several Ways of Operation; As by

*Reduction*, or bringing the Price of the Pound, Ell, Yard, &c. into the lowest Denomination of usual Money: The way to do which, see under the Word *Reduction*. And this way of Practice will be clear from these two Examples.

1. At 1 s. 2 d. the Pound, what come 152 Pounds to?

Bring all into Pence, and say, 1 : 14 :: What shall 152 give?

*Answer.*

$152 \times 14 = 2128$  d, which reduced, gives 8 l. 17 s. 4 d.

2. If 1 Pound cost 3 s. 6 d. what shall the Great Hundred and 5 Pound cost?

Reduce 3 s. 6 d. into Six-pences, i. e. 7 Six-pences; and because the Great Hundred is 112 l. the Pounds will be 117. Then the Question will stand thus.

$1 : 7 :: 117 : 117 \times 7 = 819$  Six-pences; that is, 20 l. 9 s. 6 d.

The other more usual way of *Practice*, is by Aliquot Parts. For if the Price fall out to be the Aliquot Parts, or even parts of a Pound, or a Shilling, then the Work may be shortened much; thus.

The Even parts of a Shilling are these: 6 d. the  $\frac{1}{2}$ , 4 d. the  $\frac{2}{3}$ , 3 d. the  $\frac{3}{4}$  part, 2 d. the sixth part, 1 d. ob. the  $\frac{1}{8}$  part, and 1 d. the  $\frac{1}{16}$  part.

Therefore if any Question, wherein 1 is in the First place, be proposed, and if any of these parts be in the Second; you may find the Fourth Term, by taking the one part of the Third, as in this Example.

At 6 d. the Yard, Pound or Ounce, what comes 74 Yards to?

*Answer.*

1 l. 17 s. By taking the half of 74, which is 37 s. or 1 l. 17 s.

At 3 d. the Yard, what comes 74 Yards to?

*Answer.*

18 s. and 6 d. By dividing 74 by 4.

But if the Question fall not right upon any of the aliquot Parts, then you must work oftner; as,

At 10 d. the Pound, what will 133 Pound give?

*Answer.*

5 l. 10 s. 10 d. By dividing 133 by 2 (for 6 d.) 'twill be 66 s. and 6 d. And then by 3 (for 4 d.) which makes 44 s. 4 d. in all 110 s. 10 d. or 5 l. 10 s. 10 d.

And so for 8 d. take 4 d. twice; for 9 d. take 3 d. thrice; for 11 d. take 6 d. 3 d. and 2 d.

The same may be done with the Aliquot Parts of a Pound: And to make this more plain and easie, you have here a compleat Division of the even and uneven Parts of a Pound; as also the even and uneven Parts of a Shilling.



Even Parts of a Pound.	Parts.	Uneven Parts of a Pound.	Divided into Even Parts.	Parts.
s. d.		s.	s.	
10 00	$\frac{1}{2}$	19	10 5 4	2 4 5
6 8	3	18	10 4 4	2 5 5
5 00	4	17	10 5 2	2 4 10
4 00	5	16	10 4 2	2 5 10
3 4	6	15	10 5	2 4
2 06	8	14	10 4	2 5
2 00	10	13	4 4 5	5 5 4
1 08	12	12	10 2	2 10
1 03	16	11	5 4 2	4 5 10
1 00	20	9	5 4	4 5 0
0 10	24	8	4 4	5 5
0 08	30	7	5 2	4 10
0 06	40	6	4 2	5 10
		3	2 1	16 20
Even Parts of a Shilling.		of a Shilling.	d.	
6 d.	$\frac{1}{2}$	11 d.	6 3 2	2 4 6
4	3	10	6 4	2 3
3	4	9	3 3 3	4 4 4
2	6	8	4 4	3 3
1	12	7	4 3	3 4
1 ob.	8	5	3 2	4 6

The Use of this Table is easily known from what has been said before.

PRÆAMBULE, *Præmium*, in the Law-sense, is the Beginning of an Act of Parliament, &c. and as it were a Key, to open the Intent of the Makers of the Acts, and the Mischiefs design'd to be prevented or remedied by the same.

PRÆBEND. See *Prebend*, in Vol. I.

PRÆCIPE *in Capite*, was a Writ issuing out of the Court of *Chancery*, for a Tenant holding of the King in Chief, as of his Crown, and not as of any Honour, Castle, or Mannor.

PRÆCIPE *Quod reddat*, is a Writ of great Diversity, both in its Form and Use; for which, see *Ingressus* and *Entry*. This Form is extended as well to a *Writ of Right*, as to other Writs of *Entry* or *Possession*. It's sometimes called a *Writ of Right Close*, as a *Præcipe in Capite*, where it issueth for a Tenant holding of the King in Chief, as of his Crown; and not of the King, as of any Honour, Castle, or Mannor: And sometimes a *Writ of Right Patent*, as when it issues out of the *Chancery Patent*, that is open to any Lord's Court, for any of his Tenants deforced against the Deforcer, and must be determined there.

PRECARIÆ, are Days Works, which the Tenants of some Mannors are bound, by reason of their Tenure, to do for their Lord in Harvest; called in some Places *Bind-Days*, or *Bidden-Days*.

PRÆCORDIA, are all the Intrails in the Chest or Thorax.

PRÆDICAMENT, in Logick, is a certain Class or Determinate Series or Order, in which Simple Terms or Words are ranged: Of these they usually account Ten Heads, *viz.* Substance, Accident, Quantity, Quality, Action, Passion, Relation, the Situation of Bodies as to place, their Duration as to Time, the Site or Position, and their Habit or External Appearance.

PRÆMUNIENTES, are Writs sent to every particular Bishop to come to Parliament, *Præmunientes*, or warning him to bring with him the Deans and Arch-Deacons within his Diocese, one Proclor for each Chapter, and two for the Clergy of his Diocese.

PRÆMUNIRE, is a Writ that lies where any Man sues another in the Spiritual Court for any thing that is determinable in the King's Court; for which great Punishment is ordained by divers Statutes,



Statutes, *viz.* That he shall be out of the King's Protection, and put in Prison without Bail or Mainprise, 'till he have made Fine at the King's Will, and that his Lands and Goods shall be forfeited if he come not within two Months: And his Provisors, Procurators, Attorneys, Executors, Notaries, and Maintainers, shall be punished in the same manner. See the *Statute*. And upon divers other Offences is imposed, by Statutes lately made, the Penalty they incur who are attainted in *Præmunire*: As by 13 *Eliz.* cap. 8. they who are aiding to make a corrupt bargain, whereupon Usury is reserved for above Ten Pound in the Hundred for a Year, &c.

PRÆPARANTIA *Vasa*, in Anatomy, the Preparing Vessels, are the Spermatick Veins and Arteries which go to the Testicles and *Epididymes*: (which see.) They were so called by the Ancients, as thinking they prepared the Seed.

The Arteries are two, and spring from the Trunk of the *Aorta*, about two Fingers Breadth usually, beneath the *Emulgents*; and not from its Side, but out of its Fore-part: The Right whereof climbing over the Trunk of the *Vena Cava*, runs obliquely to the Vein on the same side; and the Left marches to the Vein of that side.

The Veins also are Two: The right arises usually from the Trunk of the *Vena Cava*, a little below the *Emulgent*; the Left from the *Emulgent* itself; for otherwise it must have gone over the *Aorta*, whereby it might have been in danger of being broken; or at least, by the continual Pulse of the Artery, the Recourse of the Venal Blood might have been hindered or retarded.

Both these Arteries and Veins, a little after their Origin, do meet together, and are included in one common Membrane made of the *Peritonæum*; and then they run strait through the Region of the Loins above the Muscles *Psoæ* on each side, and above the Ureters; and as they go, they bestow little Sips here and there on the *Peritonæum*, between whose Duplicatures they descend, and so arrive at its Processes.

The Veins divide very often into many Branches, and then inosculate and unite again; but the Arteries go along by one Pipe only on each side, until within three or four Fingers breadth of the Testicles, where each is divided into two Branches; the Less whereof runs to the *Epididymis*, the Larger to the Testicle: And as they came down between the Membranes of the *Peritonæum*, so they pass into the *Scrotum* between them; not perforating the Inner in the Processes, as in Dogs and other Creatures, (wherein the Processes of the *Peritonæum* are hollow like a Quill) but in Man the inner Membrane of the *Peritonæum* shuts the Hole, lest the Intestines should fall down through it into the *Scrotum*.

It hath been formerly believed, that there are divers Inosculation between these Veins and Arteries in their Passage, whereby the Venal and Arterial Blood are mixed together; but since the Circulation of the Blood hath been known, that is discovered to be impossible, because the Blood in the Arteries descends, and that in the Veins ascends. And indeed the Blood for the Elaboration of the *Semen*, and for the Nourishment of the Testicles, flows down by the Arteries only, and that in an even and undivided Course without any of those Vine-like Tendrils, those Turnings

and Windings which have formerly so much been spoken of; as *De Graef* by his own frequent Inspection testifies. And the Veins bring back from the *Testes* what remains of the Blood after this; which Veins indeed do come out from their innermost Membrane with almost innumerable Roots, by which they imbibe the reflux Blood; and they are most admirably interwoven and inosculated with one another 'till about four Fingers breadth above the Testicles, which Space is called *Corpus Pyramidale*, *Plexus Pampiniformis*, and *Varicosus*: But these Veins are so far from preparing the *Semen*, that they only bring back what is Superfluous from the making of it. Nor indeed can the Arteries justly merit the Name of *Preparing Vessels*, because the Blood they convey to the Testicles acquires no sensible Alteration 'till it comes thither. However the Old Names are continued, but 'tis necessary to give this Caution about the Use of these Vessels.

PRÆPOSITION, in Grammar, is an Indeclinable Word, by which a Noun and a Verb are joined together, in order to signify the Cause of any thing, the Time, Place, Conjunction, Privation, &c. 'Tis called *Præposition*, because 'tis most frequently in the Latin Tongue placed before other Words; and this either separately, as *Ad patrem*; or conjunctively, as *Admiror*.

PRÆPUTIUM, *Prepuce*, [in *Anatomy*] the Fore-skin, a Prolongation of the *Cutis* of the *Penis*, which covers the *Balanus*, *Glans*, or Extremity of the Yard.

PRÆSEPE, [in *Astronomy*] three nebulous Stars in the Sign *Cancer*, two of the 7th and one of the 6th Magnitude.

PRÆSEPIA, the Holes of either Jaw, wherein are contained the Teeth.

PRAGMATICAL. A Word commonly in *English* taken in an ill Sense, and is spoken of a Medler, Busie-Body, or foolish Prater and Tattler about impertinent Things that do not belong to him. But in Physicks, or Natural Philosophy, the Word is sometimes used in a good Signification, and signifies the same as Practical, Mechanical, or Problematical. Thus *Stevinus*, in his *Hydrostatical Elements* calls some Mechanical or Practical Experiments, which he pretends to instruct his Reader how to make, by the Name of *Pragmatical Examples*; and in the same Sense 'tis sometimes used by other Naturalists.

PRAGMATICK *Sanction*, is a Term in the Civil Law for a Letter written to a Corporation, or any Publick Body, by the Emperor, in answer to their Request to enquire or know the Law of him. But if this Letter be sent only to particular Persons who have consulted him in the like Case, tis called a *Rescript*.

PRATIQUE, *Prattick*, [in *Commerce*] a Negotiation or Communication of Commerce, which a Merchant Ship obtains in the Port at which it arrives, &c. Also a Licence to Traffick granted to the Master of a Ship in the Ports of *Italy* upon a Bill of Health, which is a Certificate that the Place from whence he came is not infected with any Disease.

PRAY-Age. See *Age-prior*.

PREAMBLE, in the general, is taken for the Introduction or Beginning of any Discourse: And by the Lawyers, the Beginning of an Act is called *The Preamble*.

PREBEND,



PREBEND, is the Portion which every Member or Canon of a Cathedral Church receiveth in the Right of his Place for his Maintenance: And these *Prebends* are either *Simple*, or *with Dignity*. Simple *Prebends* are those that have no more but the Revenue towards their Maintenance. *Prebends with Dignity*, are such as have Jurisdiction annex'd to them, according to the divers Orders in every Church.

PREBENDARY, is he that hath a *Prebend*, and is so called, a *Præbendo auxilium aut consilium Episcopo vel Decano*.

PRECARIA, the same with *Bedrep*, *Binddagg* or *Bidendag*, a Day's Work; which the Tenants of some Manors are bound by their Tenure to do for their Lord in Harvest. See the great Book of the Customs of the Abbey of *Battel*, Tit. *Apeldarham*. fol. 60.

PRECE *Partium*, is when a Suit is continued by the Assent or Agreement of both Parties.

PRECEPT, in Law, is diversly taken, as sometimes for a Commandment in Writing sent out by a Justice of Peace, or other like Officer, for the bringing of a Person or Records before him. Sometimes it is taken for the Provocation, whereby one Man incites another to commit a Felony, as Theft, Murder, &c.

PRECEPTORIE, or *Commanderie*. As the larger Monasteries had formerly their remote Country Cells which were subordinate to the Mother-house of Religion; so the Knights Templars and Hospitallers sent a part of their Fraternity to some Country Cell, which was govern'd by a Person whom they called a *Præceptor* or *Commander*: And thence the Place was called a *Præceptorie* or *Commanderie*; and all these were subject to the Prime Body, who had their Principal Seats in London. *Kennet's Paroch. Antiqu.* Sixteen of these *Præceptories* we have the Names of; viz. *Cressing Temple*, *Balsball*, *Shengay*, *Newland*, *Yevely*, *Witham*, *Temple-Brue*, *Wallington*, *Rothely*, *Ovennington*, *Temple Combe*, *Trebigh*, *Ribstan*, *Mount St. John*, *Temple-New-Sam* and *Temple-Church*.

PRECESSION of the *Equinox*: In the New Astronomy, the Fix'd Stars are supposed to be immovable, and the Earth to turn round the Sun by its Annual Motion; so that its Axis makes always an Angle of 66 Degrees and an half with the Plane of its Orbit. Now if this Axis were always exactly directed to the same Point of the Heavens, or moved always precisely parallel to it self, as it doth nearly; then the Fix'd Stars would appear to have no other Motion but the Diurnal one. But because in Reality the Axis of the Earth doth a little vary from such an exact Parallelism, and doth not point always precisely to the same Star when it is in the same Place of its Orbit, but makes a small Angle with a Line imagined to lie in the Position it had formerly in the same Place: Hence it happens that the Equinoctial Points, or the common Intersections of the Equator and Ecliptick, do retrocede or move backwards from East to West, about 50 Seconds each Year; and this Motion backwards is by some called the *Recession of the Equinox*, by others the *Retrocession*; and the advancing of the Equinoxes forward by this means is called the *Procession* of them.

PRECIPE *quod Reddat*, is a Writ of great Diversity both in its form and use: For which see

*Ingressus* and *Entry*. This form is extended as well to a *Writ of Writ* as to other Writs of *Entry* or *Possession*. 'Tis called sometimes a *Writ of Right Close*, as a

PRECIPE *in Capite*, where it issueth for the Tenant's holding of the King in Chief as of his Crown, and not of him, as of any Honour, Castle or Mannor. Sometimes also 'tis called a *Writ of Right Patent*, as when it issues out of the Chancery Patent; i. e. open to any Lord's Court for any of his Tenants deforc'd against the Deforcer, and must be determined there.

PRECIPITATE. Whatever is gotten out of the Pores of a Menstruum, in which it was dissolved, and by some means is precipitated or made fall down to the bottom of the Vessel, may properly be called *Precipitate*. See *Precipitation*. But the Chymists and Writers of Pharmacy commonly give this Name by way of Eminence to the Mercury dissolved in Acid Menstruums, and then afterwards precipitated down to the bottom in fine Pouder, of which they reckon these following;

1. *White Precipitate*, which is Mercury dissolved in *Aqua-fortis*; or, which is better, Spirit of Nitre; and then precipitated to the bottom with Salt Water, and a little Spirit of Sal-Armoniack. But if instead of Salt Water, and that Volatile Spirit, you had used hot Urine, a Pouder would have fallen down, which may be called

2. *Rosie Precipitate*, since it will be of a Pale Rose Colour.

3. *Red Precipitate*, is Mercury dissolved in Spirit of Nitre, and then the Moisture is evaporated in a Sand-Heat; and then the Fire being gradually encreased to the Third Degree, the Matter turns red. Tho' this be called *Precipitate*, 'tis improperly so, here being no Precipitation at all. If Spirit of Vitriol be dropt into a little of this *Red Precipitate*, it presently turns it White; but Spirit of Sal-Armoniack will turn it Grey.

There is also another sort of *Red Precipitate* which the Chymists call *Philosophical Precipitate*, and often *Precipitate per se*; which is by including Running Mercury in a Matrafs, which is set in a Sand-Heat for Forty Days; or 'till all the Mercury is reduced to a Red Pouder.

4. *Green Precipitate*, is made by mingling the Dissolutions of Mercury and Copper together, both made in Spirit of Nitre; the Mixture is evaporated to Driness, and then the Mass at the bottom is poudered, and hath distilled Vinegar poured upon it, and digested with it for Twenty four Hours, or 'till the Liquor looks Green, and a little Bluish; then the Liquor is poured off, and more Vinegar put on, and so repeated 'till all be dissolved: Then all these Dissolutions are mixed and evaporated in a Sand-Heat 'till the Matter be of the Consistence of Honey; then taken off the Fire, it will harden as it cools, and grow pulverizable. The Pouder of it is this *Green Precipitate*, as improperly so named as the other *Red Ones*.

5. *Yellow Precipitate*. See *Turbith Mineral*.



If Sublimate Corrosive be dissolved in Water, a little Oil of Tartar *per Deliquium*, poured into the Solution, will make a *Red Precipitate*; and Spirit of Sal-Armoniack will give, from some more of the same Solution, a *White Precipitate*; and Lime-water will give the Solution a Yellow Colour, as you may see in the *Phagædenick Water*: And a little Spirit of Vitriol will clear off these Precipitates and Colours, and render the Liquor greatly transparent and colourless like fair Water.

All these Precipitates, or any other, may easily be revived into Running Mercury, by mixing them with Quick-lime, and then distilling, as in Reviving Mercury from *Cinnabar*; which see.

PRECIPITANT, [in *Chymistry*] a Term apply'd to any Liquor which being poured on a Dissolution, separates what is there dissolv'd, and makes it Precipitate, *i. e.* fall down to the Bottom of the Vessel.

PRECIPITATION, in *Chymistry*, signifies the Falling-down of the Particles of any Metalline or Mineral Body, which are kept suspended in that Menstruum which dissolved it, by the pouring in of some *Alkalizate*, or other contrary Liquor; or by putting something else into it, which is more easie for the *Menstruum* to dissolve. Thus if Silver be dissolved, and its Particles kept suspended in *Aqua-fortis*, Spirit of Nitre, &c. some Oil of Tartar *per Deliquium*, or even Salt Water, will presently make the Acid let go the Silver, and it will fall down or precipitate to the bottom in a White Pouder: Or if into the Solution of Silver you had put a Plate of Copper, this Metal being easier to work upon than the Silver, the Acid will fall to dissolving of it, and consequently let go the Silver, which will soon precipitate or fall down to the bottom, and cover the Copper Plate all over with White Scales. See the Word *Depart*.

Mr. Boyle defines Precipitation in general to be an Agitation or Motion of an Heterogeneous Liquor, which in no long time will make the Parts of it subside, and that usually in the Form of a Pouder or other consistent Body.

This Noble Gentleman proposes, That the Corpuscles contained or kept suspended in any Solvent or Menstruum, may be precipitated down by either or both of these two general ways: 1. By adding to the Weight or Bulk of the dissolved and floating Particles, and thereby rendering them unfit any longer to accompany the Particles of the Menstruum in their Intestine Motion: Or, 2dly, by weakening the Sustaining Power of the Menstruum, and thereby disabling it to keep the dissolved Particles from swimming any longer in it. See more in his excellent Discourse upon the Mechanical Causes of Precipitation.

PRECIPUT [in *Juris-prudence*] an Advantage, which belongs to any one, in a Thing that is to be divided; or it is a Portion that is taken off or set by in his Favour, before the Division is made.

PRECONTRACT, is a Contract (usually understood of Marriage) which was made before another Contract, and consequently as far as 'tis contrary to and inconsistent with, annuls the latter.

PREDIAL Tythes, are those which are paid of Things arising and growing from the Ground only, as Corn, Hay, Fruit of Trees, &c.

PREDICABLE, in Logick, is a common Term or Word that may be attributed to more than one Thing. Thus the Word Triangle refers to any Figure having but three Sides and Angles, whether it be Rectilineal or Spherical.

PREDICAMENT, [in *Logick*] a Class or Order of Beings or Substances, rang'd according to their Nature, called also *Categorema* or *Category*.

PREDY, a Sea Word, signifying the same with *Ready*. *Predy the Ship*, or *Predy the Ordnance*, is, as much as to make Things ready for a Fight: *Predy the Hold*, is to lay or stow every thing there in its due order and proper place.

PRE-EMPTION, was formerly allowed to the Crowns Purveyor, to have the first buying of all Corn, other Provisions, &c. before others. See 12 Car. c. 24.

PREIST's Cap, a Term in Fortification. See *Bonnet a Prestre*.

PRE-FINE, (in Law) is that Fine which is paid on Suing out the *Writ of Covenant*.

PRELUDE, in Musick, signifies any Flourish that is Introductory to Musick which is to follow after.

PREMISSSES. See *Habendum*.

PREMIUM. A Term used by Merchants for that Sum of Money which the Ensured gives the Ensurer for the Ensuring the Safe Return of any Ship or Merchandise.

PREMUNIRE. See *PRÆMUNIRE*.

PRENDER, is the Power or Right of taking a Thing before it is offered.

PRENDER *de Baron*, is usually taken in Law for an Exception, to disable a Woman from pursuing an Appeal of Murder against the Killer of her former Husband.

PREPENSED, in Law, is when a Man is slain upon a sudden Quarrel; yet if there were Malice *prepensed* formerly between them, it makes it *Murder*; as it is called in some Statutes *prepensed Murder*.

PREPOSITUS *Villæ*, some will have to be the Constable of a Town, or Petit-Constable. 'Tis also sometimes used for a *Reeve*: For others say, in our Old Records, it signifies the *Reeve* or *Bailiff* of the Lord of the Manor who is sometimes called *Serviens Villæ*. But by the Laws of K. Henry I. the Lord answered for the Town where he was Resident: Where he was not present his Deputy or Seneschal was responsible if he were a Baron. But if neither of them could be present, then the *Præpositus & quatuor de unaquaque villa*, the *Reeve* and 4 of the most Substantial Inhabitants were summoned in.

PREROGATIVE Court, is the Court wherein all Wills are proved, and all Administrations taken that belong to the Archbishop by his *Prerogative*; that is, in Case where the Deceased had Goods of any considerable Value out of the Diocese wherein he died; and that Value is commonly 5 l. except it be otherwise by Composition between the said Archbishop and some other Bishop, as in the Diocese of London it is 10 l.

And if any Contention grow between two or more, touching any such Will or Administration, the Cause is properly debated in this Court; the Judge whereof is termed *Judex Curiae Prærogativæ Cantuariensis*, the Judge of the *Prerogative Court of Canterbury*.

The Archbishop of York hath also the like Court, which



which is termed *His Exchequer*; but far Inferior to this in Power and Profit.

**PRESBYTÆ**, are those Men who by Old Age, or other Accidents, have the Globe of the Eye so flat, that the produced Visual Rays pass the *Retina* before they unite; whereby there can be no distinct Vision, since the distinct Base falls too far off beyond the *Retina*: Therefore this Defect is to be helped by Convex-Glasses or Spectacles, which will make the Rays converge sooner, and, if they are well fitted, exactly on the *Retina*.

**PRESBYTERIUM**, the *Presbytery*; The Choir or Chancel of a Church; so called because that Place was appropriated to the Bishops and Priests, and other Clergy; while the Laity was confined to the *Nave* and Body of the Church, *Cowel's Interpreter*.

**PRESCRIPTION**, in Law, is when a Man claims any thing, because he, his Ancestors or Predecessors, or they whose Estate he hath, have had or used it all the time whereof no Memory is to the contrary. But one cannot prescribe against a Statute, except he hath another Statute that serves for him.

**PRESENTATION**, a Term in Law, properly used for the Act of a Patron, offering his Clerk to the Bishop, to be instituted in a Benefice of his Gift.

**PRESENTÉE**, is the Clerk that is so presented by the Patron. Also the King's *Presentee* is he whom the King presents to a Church.

**PRESENTMENT**, in Law, is a meer Denunciation of the *Jurors* themselves, or some other Officer, as *Justice, Constable, Searcher, Surveyor, &c.* (without any Information) of an Offence inquireable in the Court whereunto it is presented.

**PRESIDENT**, in a Legal Sense, is the Crowns Lieutenant in a Province or Function: As the President of *Wales, York, Berwick*; of the King's Council, &c.

**PRESSING to Death**. See *Peine forte & dure*.

**PRESSURE**; by this Word some Philosophers, addicted to the Cartesian Hypothesis, mean a kind of Motion which is impressed upon and propagated through a Fluid Medium. And by this they would explain all the Phænomena of Light and Colours, as well as of many other Effects; by certain new Modifications which do there happen to the Rays of Light, as they are usually called. But as our Excellent Sir *Is. Newton* shews, (p. 307 of the Latin Edition of his Opticks) this is a Mistake.

For if Light (for Instance) consisted only in *Pressure*, propagated without Actual Motion, it could not therefore agitate and warm such Bodies as Reflect and Refract it: And if it consisted in an *Instantaneous Motion*, or one propagated to all Distances in an Instant, as some have advanced; there would be required an Infinite *vis* or Force, to produce that Motion, every Moment, in every Lucent Particle. And if Light consisted either in *Pressure*, or in Motion propagated in a Fluid Medium, whether instantaneously or in Time, it must from thence come to pass, that it should inflect itself in *umbram*. For *Pressure* or Motion in a Fluid Medium cannot be propagated in *Right Lines*, beyond any Obstacle which shall hinder any Part of the Motion; but will inflect and diffuse itself every Way into those Parts of the Quiescent Medium which lie beyond the said Obstacle.

Thus the Force of Gravity tends downward, but

the *Pressure*, which arises from that Force of Gravity tends every Way with an Equable Force: And with equal Ease and Force, is propagated in Crooked Lines as in Straight. Waves on the Surface of Water while they slide by the Sides of any Large Obstacle, do inflect, dilate and diffuse themselves by Degrees, into the Quiescent Water lying beyond the Obstacle. The Waves, Pulses, or Vibrations of our Air in which Sounds consist, do manifestly inflect themselves, tho' not so much as the Waves of Water; for the Sound of a Bell or of a Cannon, can be heard over a Hill, which intercepts the Sonorous Object from our Sight: And Sounds will be propagated as easily thro' *Crooked Tubes*, as thro' *Straight*: But Light is never observed to go in *Curve Lines* nor to inflect it self in *Umbram*. For the fixed Stars do immediately disappear on the Interposition of any of the Planets, as well as some Parts of the Sun's Body, by the Interposition of the *Moon, Venus* or *Mercury*.

**PREST**, is used for a Duty in Money to be paid by the Sheriff, upon his account, in the *Exchequer*; or for Money left or remaining in his Hands.

**PREST Money**, from the French *Prest, ready*; is Money given to Soldiers when they are *Prest*: And binds such as receive it to be *ready* at Command at all Times appointed by their Officers.

**PREST Sail**: A Ship at Sea is said to *carry a Prest Sail*, when she carries all that she can possibly Croud: Which is sometimes done in giving Chase to an Enemy: But 'tis a dangerous Experiment and ought not to be tryed often, lest a Ship should over-set, or bring her Masts by the Board, in which latter Case she will become a Prey to the Enemy.

**PRESTATION Money**, was according to some, a Sum of Money paid by the Arch-Deacons to the Bishops annually *pro Exteriori Jurisdictione*: But others say it was a *Subsidium Charitativum*, which in reasonable Cases a Bishop might require of his Clergy.

**PRESTER**, [*πρεστερ*, &c.] a Meteor which consists of an Exhalation thrown from the Clouds downwards, with such Violence, as that it is set on Fire by the Collision.

**PRESUMPTION**, in Law, is of Three sorts; 1. *Violent*, which is many times a full Proof; as if one be killed in a House, and a Man is seen to come out of the House with a bloody Sword, and no other Person was at that time in the House: This, tho' but a *Presumption*, is as a Proof. 2. *Probable*, which hath but a small Effect. 3. *Levis, seu temeraria*, which is of no Prevalency at all. So in case of a Charter or Feoffment, if all the Witnesses to the Deed be dead; the *Violent Presumption*, which stands for a Proof, is Continual and Quiet Possession.

**PRETENCE**. See *Escutcheon of Pretence*.

**PRETENSED Right or Title**: *Jus Prætensum*; where one is in Possession of Lands or Tenements, and another who is out, claims it and sues for it. Here the *Pretensed Right or Title*, is said to be in him who doth thus Claim or Sue.

**PREVARICATE**, in Law, is when a Man falsely and deceitfully seems to undertake a Thing, *ea intentione*, that he may destroy it.

**PREVARICATION**, in the Civil Law, is where an Informer colludes with the Defendant, and so makes only a feigned Prosecution.

**PERVEN.**



**PREVENTER Rope**, in a Ship, is a small Rope used to secure the Ties, so that if one Part should break, the other may not run thro' the Ram-head. See *Ropes*.

**PREVENTION**, [in the *Canon Law*] the right which a superior Person or Officer has to lay hold of, claim or transact an Affair before an Inferior, to whom it more immediately belongs.

**PRIAPISMUS**, [in *Medicine*] a continual or painful Erection or Tension of the Yard.

**PRICK**. To prick the Chart or Plot at Sea, signifies to make a Point in their Chart whereabout the Ship is now, or is to be at such a time, in order to find the Course they are to steer, &c.

**PRICK-Posts**, in a Building, are such as are framed into the *Breast-Summers* between the principal Posts for strengthening the Carcase of the House.

**PRIMANATURALIA**, [in *Physicks*] are Atoms of the first Particles of which natural Bodies are primarily composed, the same that are called *Minima Naturalia*. L.

**PRIMÆ Viæ**, [in *Physick*] the first Passages of the Chyle as the Stomach, Intestines and their Appendices. L.

**PRIMAGE**, is a Duty due to the Mariners and Sailors for the Loading of any Ship at the setting forth from any Haven. *Anno 32 Hen. VIII. c. 14.* which in some Places is a Penny in the Pound: In others Sixpence for every Pack or Bale, &c. according to the Custom of the Place.

**PRIMARIUM Latus**, in Geometry, is a Right Line in any Conick Section, drawn through the Vertex of the Section, and parallel to the Base of the Cone.

**PRIMARY Planets** (according to some) are the Three Superior Planets, viz. *Saturn, Jupiter, and Mars*; but more properly a *Primary Planet* is one that moves round the Sun, as its Centre; whereas a *Secondary Planet* moves round some other Planet.

**PRIME Figure**, is that which cannot be divided into any other Figures more simple than it self; as a *Triangle in Planes*, the *Pyramid in Solids*: For all Planes are made of the First, all Bodies or Solids compounded of the Second.

**PRIME Numbers**, in Arithmetick, are those made only by *Addition*, or Collection of Unites, and not by *Multiplication*: So an Unite only can measure it; as 2, 3, 4, 5, &c. and is by some called a *Simple*, by others an *Uncompound Number*.

**PRIME of the Moon**, signifies the *New Moon*, at her first Appearing, or about three Days after the *Change*, at which time she is said to be *primed*.

**PRIME Verticals**, or *Direct Erect North or South Dials*, are those whose Planes lie parallel to the *Prime Vertical Circle*. But since every Plane hath that Pole raised or depressed thereon, which lieth open to it: Therefore this Plane (if a *Direct South*) hath the South Pole elevated, and consequently the Style (whose Height must be the Complement of the Latitude of the Place) will point downwards.

Wherefore, To find the Hour's Distance from the Meridian upon this Plane, the Proportion is,

As the *Radius* is to the Sine of the Style's Height, or Co-Latitude;

So is the *Tangent* of the Hour, or Angle at the Pole,

To the *Tangent* of the several Hours Distance from the *Meridian*.

By this *Canon*, the Hours requisite for the Plane, as also the Half Hours, Quarters, &c. being calculated and set in a Table; the *Dial* is described after the same manner as the *Horizontal Dial*; which see.

*North Direct Erect Dials*, are but the Backside of the *South*, because lying in the same *Azimuth* with it: Therefore, 'tis no more but turning the *South Dial* upside down, and leaving out the Superfluous Hours between 5 and 7, and 4 and 8, and the *North Dial* is made. Only note; That the Style must point upwards to the North Pole.

**PRIMER Seisin**. The first Possession of *Seisin* was heretofore used as a Branch of the King's Prerogative, whereby he had the First Possession; that is, the entire Profits for a Year of all the Lands and Tenements where his Tenant (that held of him *in Capite*) died *seised* in his Demesne as of Fee, his Heir then being at full Age, until he do his Homage; or if under Age, until he were of Age. But all the Charges arising by *Primer Seisin*, are taken away by the Statute made 12 Car. II. cap. 24.

**PRIMES**, are the first larger Divisions of the single Number on *Gunter's Line* of Proportion, whose next Subdivisions are called Tens, &c. See *Line of Proportion*.

**PRIMING Iron**, is a small sharp Iron which is thrust into the Touch-hole of a Great Gun, and pierces into the Cartridge that holds the Powder, that so they may put in the Prime-powder or Touch-powder to fire off the Piece.

**PRIMITIÆ, First-Fruits**: In our Law, the Profits, after Avoidance, of every spiritual Living as rated in the King's Books, for one Year.

**PRIMITIVE** [in *Grammar*] a Root or a Word in Language, which is neither deriv'd from any other Language, nor compounded from any other Words of the same.

**PRIMO Beneficio Habendo** [in *Law*] a Writ that is directed from the King to the Lord Chancellor, appointing him to bestow the Benefice that shall first fall in the King's Gift above or under such a Value upon this or that Clerk.

**PRIMOGENITURE**, in Law, is the Title of an Elder Brother in Right of his Birth.

**PRIMORES Dentes, seu Incisivi Dentes**, are the Four Foremost Teeth in each Jaw; they are pretty broad, sharp at their Ends, a little Convex outwards, and hollow inwards: They have each a pretty long Root, a little crooked, and divided into two, by which means they have the greater Force in cutting off the Aliments, which is their proper Use.

**PRIMUM Mobile**, in the *Ptolemaick Astronomy*, is supposed to be a vast Sphere, whose Centre is that of the World, and in Comparison of which the Earth is but a Point: This they will have to contain all other Spheres within it, and to give Motion to them, turning it self and all them quite round in Twenty four Hours.



PRINCIPAL, in Common Law, signifies the same with *Heirloom*.

PRINCIPAL Ray, in Perspective, is the Perpendicular one which goes from the Spectator's Eye to the Vertical Plane or the Table. And the Point where this Ray falls on the Table, is called from hence the

PRINCIPAL Point, which some Writers call the *Centre of the Picture*, and the *Point of Concurrence*.

PRINCIPAL Posts, in any wooden Building, are the Corner Posts, which are tenanted into the Ground Plates below, and the raising Plates above, *i. e.* into the Beams of the Roof.

PRINCIPLE, a Word very commonly and very variously used; sometimes it signifies the same as a Maxim, an Axiom, or a good Practical Rule of Action: Thus we say, a Person is a *Man of Principles*, when he always acts according to the Eternal Rules of Morality, Virtue and Religion.

Sometimes it signifies a Thing Self-evident, and as it were Naturally known, and then 'tis usually called, a *First Principal*; as that, *Nothing can Exist and not Exist at the same time*: That, *Where there is no Law, there is no Transgression*: That a *Whole is greater than a Part*.

Sometimes it hath the same sense with Rudiments or Elements; as when we say, the *Principles of Geometry, Astronomy, Algebra*; we mean the Doctrines or Rules of those Sciences.

And in Chymistry particularly, 'tis taken for the first Constituent and Component Particles of all Bodies, out of which they are made, and into which they are by Fire, as they say, resolvable again. Thus *Salt, Sulphur, and Mercury* are the three Famous Chymical Principles, which they call *Hypostatical*; and the Chymists did formerly pretend, that they could by their Art resolve all Natural Bodies into these; and that these Principles could be drawn Simple, Pure, and Uncompounded from Metals, &c. But since this Art hath been more commonly studied and consequently much better known, it is found to be a Falsity, as Mr. Boyle excellently shews in his *Sceptical Chymist*; and Lemery hints in many places of his good *Course of Chymistry*.

The Modern Chymists agree that there are five kinds, or different sorts of Bodies, which may by Fire be drawn from many mix'd Natural Bodies, and therefore which may in a large sense be called *Principles*; as, *Earth, Salt, Spirit, Phlegm, and Oil*, tho' these can never be drawn, perfectly Pure and Unmix'd; nor have we any reason to believe they are the Constituent Principles of the Bodies they are drawn from; and out of many Bodies hardly ever a one of them can be drawn; and therefore they are not truly and properly the Elements or Constituent Principles of Natural Bodies, nor indeed do we know any such.

Of these, the *Spirit, Oil and Salt*, are called the *Active Principles*; and the *Water and the Earth*, the *Passive ones*.

Mr. Boyle sheweth by many Experiments in his *Sceptical Chymist*, in the Discourse about the *Producibleness of Chymical Principles*, in his Chymical Paradox at the end of his *Noctiluca*, and in many other places that these Chymical Principles are Producing and Destructible, and that they are

manifestly Transmutable into one another. For by distilling what the Chymists call Essential Oil of Anniseeds 36 times over, and some other Oils of Vegetables above 50 times, he found that there would be produced above half the first Weight of the Oil in the form of a Black Pitch. That an acid and volatile Spirit and Salt were to be gained in a considerable Quantity; and upon the whole it appeared that these Resulting Bodies of such very different Forms were produced by the Action of the Fire transmuting part of the very Substance of the Oil into them.

That in general may be called a Principle which is the first Cause of any Thing's *Existence*, or *Production*, or of its becoming *Known* to us.

The Aristotelian or Peripatetical Principles are the Four Elements, *Earth, Water, Air, and Fire*.

The Epicurean Principles, are Magnitude, Figure, and Weight.

Mr. Boyle thinks as the World now is (for they can't account for its Creation) that the Mechanical Principles, Matter, Motion, and Rest, are Principles sufficient to solve all the Phænomena of Nature.

The Cartesian Principles are these three following; *First*, A most Subtle Matter very swiftly agitated, fluid, and keeping to no certain Figure, but which suits it self to the Figure of those Bodies that are about it; *The Second* are very small Globules, that is, Bodies exactly round, and very solid, continually whirling about, and which do not only like the *First Principles*, fill up the Pores of Bodies, but also constitute the purest Substance of the *Æther and Heaven*. *The Third Principle* is a Matter consisting of more thick and Branchy Parts, full of Angles and unfit for Motion, of which the *Earth, Water, Air, and all mixed Bodies* do consist.

Now they suppose these three Elements to be thus produced: The whole World being a Plenum and the Particles, or Atoms, of all Matter solid, as soon as Motion was superinduced into the World, these Atoms being of several Shapes, and Sizes, would begin to rub and grind one against another.

By which means, some would come to be ground or turn'd round Globules; and these constitute their Second Element. The small Chips, Shavings, or Dust, that comes off in the forming of these Globules, is the Matter of their First Element; and these must needs be in every rapid Motion. But those Particles which are not yet turned into Globular Figures, will be variously angled, and not so fit for Motion as the others; and therefore will constitute a Third Element very different from the others.

PRINTING. There is a Dispute between the Towns of *Harlem* in *Holland*, and *Mentz* in *Germany*, about the Invention of this noble Art.

The *Harlemers* say, that *Laurenz Janz's Koster* of *Harlem*, was the first Inventor of *Printing*, A.D. 1430. But that at first he used only wooden Blocks or Plates, (like those used in *China* and some other Eastern Countries, where that kind of Printing hath been much longer in Use, and perhaps gave the first Hint to our Manner of Printing now in Use;) tho' after some Time he left those off, and cut single Letters in Steel, which he sunk into Copper *Matrices*, and fitting them into Iron Molds, cast single Letters of Metal in these *Matrices*.

They



They say also, that his Companion *John Guttenburgh* stole his Tools away while he was at *Church*, and with them went to *Mentz* in *Germany*; where setting his stolen Instruments to work, he claim'd the first Invention of this Art before *Koster* did his.

To prove this, they say that one *Rabbi Joseph*, a Jew, in his Chronicle, mentions a printed Book that he saw at *Venice* in the Year 5288, according to the Jewish Account, and of ours, 1428, as may be seen in *Pet. Scriverius*.

But notwithstanding all this, and also what they say further of a Book entituled *De Spiegel*, which they shew printed at *Harlem* in *Dutch* and *Latin*, tho' without Date; but they pretend it to be the first that was ever printed: Notwithstanding this says *Moxon*, *Guttenburgh* of *Mentz* is more generally taken for the Invention of Printing; than *Koster* of *Harlem*.

*Dr. Wallis* saith, this Art was first invented about the Year 1460, and was practised in *Germany* immediately, but whether first at *Mentz* or *Harlem*, he determines not. He saith the Book which bears the Repute of being the first that ever was printed, is *Tully's Offices*; which was printed in the Year 1465 or 1466; for the Copy of it in the *Bodleian Library* in *Oxon*, disagrees a Year with that in the Library of *C. C. College* there. In that Book in the *Bodleian Library*, is a Note written which mentions one *Johannes Faustus*, as Coadjutor to *Guttenburgh*, as also *Peter Scheffer*, on the same Account; and this *Scheffer*, *Joh. Arnoldus* in *Libello de Chalcographiæ Inventione*, makes the Invention of the *Matrices*. These three work'd together a while, and then parted.

There is also another Note written in a later Hand, in the said Book, which refers the first Invention of *Printing* to the Year 1543; but most to the Year above-mentioned by *Dr. Wallis*, viz. 1460.

Next to these two Places of *Mentz* and *Harlem*, it seems to have been practised first at our University of *Oxon* in *England*: For *K. Hen. VI.* and *Thomas Bouchier*, then *A. B.* of *Canterbury*, sent *William Turner*, Master of the Robe, and *William Caxton*, Merchant of *London*, over to *Harlem* to learn this Art, who privately prevailed with one *Frederic Corseles*, (an Under Workman) for a Sum of Money to come over hither; who did so, and at *Oxford* set up the Art of Printing, before it was used any where else, except in *Mentz* and *Harlem*. And there is a Treatise said to be of *S. Jerom*, (because found in his Works) but in Reality of *Ruffinus* on the Creed, printed at *Oxon*, in a broad Octavo, in the Year 1468, which is but three Years after the Edition of *Tully's Offices* at *Mentz*; and perhaps is one of the first Books printed on Paper, for that of *Tully* was on Vellum. Soon after this, *Caxton* (who first brought it, as is supposed, to *Oxford*) promoted it to *London*; which *Baker* in his Chronicle saith was about 1471: But *Moxon* in his Art of Printing saith, he had not seen any Books printed at *London* before 1480; about which Time it was received in *Italy*, *Germany*, &c.

In *Philos. Transactions*, N. 288, and 310, there is this further Account of the Rise and Progress of the Art of Printing.

*Boxhornius Schrevelius*, and other Authors say, That *Koster* could not, nor did he in Fact print so

large a Book as the *Speculum Salutis*; without gradual Improvements; and his first Essays were on small and loose Leaves of Paper before he attempted whole Books.

In the *Bodleian Library* at *Oxford* are two Books; and in that of *Bennet-College* in *Cambridge* is another very ancient printed Book, printed only on one Side of the Paper; the whole wrought, or cast on Wood, nor set or composed with Printing Letter, and printed with Writing-Ink; which do sufficiently shew that they were done when this Art was in its Infancy, and are very probably the Work of *Koster*; but they are without Date or Printer's Name.

*Koster* had an Assistant whose Name was *John Fust*, or as some write him *Faust* or *Fauslus*; from whom he took an Oath of Secrecy, as *Schrevelius* tells us, but *Fust* ran away with *Koster's* Tools and Materials, and in some time set up a *Printing-Press* at *Mentz*, where he was assisted by his Servant *John Scheffer*, a young Man of a good Genius, and who afterwards married his Daughter, and became his Partner. They tell a Story also of *Fust's* going to *Paris*, but whether before or after he settled at *Mentz*, is uncertain, and offering there a great Number of printed Bibles to Sale, as if they were Manuscripts: But the *French* considering the Number of these Books, and their exact Conformity one to another throughout the whole, to a Line, a Word, a Letter, nay even to a Point, and that the best of Book-writers could not be thus exact, forc'd the Secret out of him, by either actually indicting him for a *Magician*, or threatening him at least so to do; and this 'tis said gave Rise to the Story of *Dr. Faustus*.

And 'tis probable about this Time many printed Books were sold up and down for Manuscripts.

'Tis not certain in what Year *Fust* and *Scheffer* began first to work at *Mentz*. But *Schrevelius* saith, *Fauslus* (as he calls him) printed *Alexandri Doctrinale cum Petri Hispani Tractatibus*, A. D. 1442. And *Lambetius* in *Comment. de Biblioth. Cæs. Lib. 2. p. 983.* saith, that he brought from *Inspruck* to the Imperial Library at *Vienna*, a *Psalter* printed on Parchment by *Fust* and *Scheffer*, 1457. And soon after this Date many Books were printed, which are still in Being: as the *Durandus* in the Library of *Basil*, printed 1458. *Johannis Johannensis Catholicon*, in his Majesty's Library, printed 1460. The Latin Bible of 1462 in the *French King's Library*, all before the *Tully's Offices* above-mentioned; which was not printed till 1465 or 1466. The first Book printed here in *England*, was the *Ruffinus*, printed at *Oxford* 1468, as was said before. But they practised the Art earlier in other Countries; and in particular, it was used at *Rome* in the Palace of *Maximi*, A. D. 1455, by *Conrad. Sweinheim*, and *Arnold Pannartz*, both *Germans*, and who continued Printers there many Years after, as *Martellinus* in his *Romæ Sacra* affirms.

Some think that Paper, (made of Linen Rags) was first made at *Basil*, by some Greeks, who fled out of their Country after *Constantinople* was sackt, A. D. 1452; and this in Imitation of the Cotton Paper used in the *Levant*. Certain it is the Cotton Paper hath been of very ancient use in the East; there being in the *Bodleian Library* an *Arabick Manuscript* (among those the University bought of *Dr. Huntington*) written in the 427th Year of the *Hegira*,



*Hegira*, which is *A. D.* 1049, on this Paper; and some there are without Dates, which seem older.

And as for the Linen-Rag-Paper, it must be much older than 1452; for in the Archives of the Library of the Dean and Chapter of *Canterbury*, there is an Inventory, on our Paper, of the Goods of *Henry Prior of Christ's Church* there, that is in the 20th Year of *Edw. III.* which is *A. D.* 1346. and in the *Cotton Library* are several Writings, on our Paper, as high at least as the 15th of *Edw. III.*

Some think the *Rolling-Press* was invented by *Lipfius*; but there is a printed Book in the *Bodleian Library*, (placed *Laud. p.* 138.) being a *Missale secundum usum Eccles. Herbipolensis*, (i. e. *Wurtzburg*) in *Germany*. At the Beginning of this Book is an Instrument of *Rodolphus the A. B.* of this Church, containing the Reasons of the Publication of this *Missale*, and instead of a *Seal*, there is annexed a Print engraven of the Arms of the See, &c. very finely done (for that Time, for 'twas before *Durer*) and on which are evident Marks of the *Pressure* by the *Plate*, with some Touches of Ink at the Edges, &c. which all that have seen it judge to be plain Marks of its being done or wrought off in a *Rolling-Press*. And there are sufficient Reasons to prove that this Book is as ancient as 1481.

Mr. *Bagford* thinks we had not the first Hint of Printing from the *Chineses*, of whom we had no Knowledge hardly, when this Art was invented: But rather from *Old Medals, Seals, &c.* and the Letters on them. But if it be certain, as it seems to be, that Cards are as old as *Hen. VI.* nothing seems to give a better Hint to the Invention of Printing than Card-making, as is evident by the first Specimen of Printing at *Harlem*; and by those Books above-mentioned in the *Bodleian Library*, and that of *Bennet-College* in *Cambridge*.

The cutting of the Molds or Blocks for making our Playing Cards, is after the same Manner as that of the old Books first printed at *Harlem*. They lay a Sheet of wet or moist Paper on the Form or Block, being first lightly brushed over with Ink made of *Lamp-Black* mixt with Starch and Water. Then they rub it off with a round List with their Hand, which is done with great Expedition. They colour the Court Cards by the help of several Patterns or *Stanesfiles*, as they call them; being Card-Paper cut thro' with a Penknife for every Colour, as *Red, &c.* (for at the first Printing, the Card hath only a meer Out-line.) These Patterns are painted with Oil-Colours to keep them from wearing out by the Brushes; for they lay it upon the Picture, and by sliding a Brush that is full and loose over the Pattern, it fixes the Colour into the cut Holes, and leaves it on the Print that is to be a Card; and so they go thro' with all the Colours on the Cards: This very probably was the Way of their first Printing at *Harlem*, as might have been discovered before this, if they had consider'd that the *Great Letters* in our old *MSS.* (of 900 Years old) are done by the Illuminators, after this of *Card-making*.

The next Form of Printing in *Harlem* was by cutting whole Forms in Wood from *MSS.* exactly written, and without Pictures. Such perhaps was the *Donatus*, which might bear Date about 1450; some say, 1440. This appears plain, saith Mr. *Bagford*, from Copy Books which we have seen

printed at *Rome, Venice, Switzerland, and England*, as high as 1500.

The third way of Printing was with *single Types* made of Wood; but who invented this is not known; it was at first esteemed so great a Rarity, that the Printers carried about their Letters in Bags at their Backs, and got Money at great Mens Houses by printing the Names of the Family, Epitaphs, Songs and other small Pamphlets.

The fourth Improvement of this noble Art was the Invention of *Single Types* made of Metal: which is owing to *Peter Scheffer*, above-mentioned, first Servant, and then Son-in-Law to *Faustus*, who work'd at *Mentz*. Sometimes you have the Names of these two Men printed at the End of their Books, and sometimes not; sometimes with Dates as high as the Year 1457, and as low as 1490.

As for *John Guttenburgh*, who by many Authors is said to be the first Inventor of Printing, we cannot find one Book with his Name and Printing.

As the first *Harlem* Printing was only a Book with Pictures, and the Impression taken off with a List coiled up, as our Card-makers do now use; so when they came to use *single Types*, they made use of stronger Paper, with Vellum and Parchment, and then the *Press* was first used; tho' afterward much improved; as was their *Printing-Ink*.

*Rolling-Press-Printing* was not used in *England* till *K. James I.* and then brought hither from *Antwerp* by our industrious *John Speed*.

As to the Art or Practice of *Printing* it self, 'tis so useful to the Common-wealth of Learning, to have it better understood by Authors and Editors of Books than it usually is, that I shall here give a full but succinct Account of the whole Matter from Mr. *Moxon's* Mechanick Exercises of Printing; and from what I could collect from my own Observation, or get by Information.

The principal Officer in this Affair is called the *Master Printer*: Who contrives or finds a Room or Rooms, for setting up what they call a *Printing-House*; or who furnishes a *proper Place*, with all Tools and Instruments used in Printing.

And first he must consider what Number of *Presses* and *Cases* he shall want that his Room may be proportionate to his Number. They usually allow about 7 Foot square on the Floor, for each *Press*: And for every *Frame* of *Cases*, which holds two pair of *Cases*, viz. a pair of *Roman* and a pair of *Italick*, five Foot and a half in Length and four and a half in Breadth; tho' they contain but 2 Foot and 9 Inches: But then Room enough will be left to pass freely between the Frames.

The *Cases* must be so placed that the Light may fall to the left Hand of the *Compositor*; or else his Hand will interpose between the Light and his Eyes, and so shadow or obscure the Letters he is to take up.

The *Presses* also must be so placed as that the Light may fall from a Window right before the *Form* and *Tympan*.

The *Correcting Stone*, or *Stones* must also stand against a good Light; and as near as can be in the Middle of the Room, if there be but one, that the several *Compositors*, may come the better to it.

In some Corner of the Room with a Sink under it, must the *Lee Trough* and *Rinsing Trough* be placed; or in some other Place if there be Room enough.



The *Distributing Frame* stands also pretty near the Middle of the Room; and round about the Sides *Nest Frames* may be placed to hold the *Cases*, that lie out of present Use; and the *Letter Boards*, with *Forms* set on them; that both the *Cases* and the *Forms*, may be the better secured from running to *Pye*.

Having thus contrived his Room or Rooms to the best Advantage; it is next to be furnished with its proper Materials as *Letter, Cases, Presses, Chases*, &c. of which next in Order.

#### Of Letter.

The Printer must be provided with a good *Fount* as they call it, or *Found* of *Letter*, and of all *Bodies*: For most Printing Houses have all these that follow, except the two first: And the *Dutch* (and I believe the *French* of late) have several other *Bodies*, and we have one more, which is sometimes used in *England*, which they call a *Small Pica*: But this differs but little from the *Pica*.

These *Bodies*, are commonly cast with a *Roman*, *Italick*, and sometimes an *English Face*: But the Printer hath also some *Bodies* with *Hebrew*, *Syriack*, *Greek*, and with the *Musick Face*: As also *Characters*, *Mathematical*, *Chymical*, *Algebraical*, &c. The following Table shews the Names and *Sizes* of these several *Bodies*: Or what Number of each Body is contained in a Foot.

Pearl	148	} contain'd in a Foot.
Nompareil	150	
Brevier	112	
Long Primer	92	
Pica	75	
English	66	
Great Primer	50	
Double Pica	38	
Two-Lined English	33	
Great Cannon	17 $\frac{1}{2}$	

In the Choice of his *Letter*, a Printer hath great Scope to shew his Judgment and Skill as to their Shape, &c. and I think in the whole, the Preference must be given to the *Dutch Types* or *Letters*: But be their Shape what it will, the Letters must be deep cut, that they may print clear, last longer, and be less subject to entertain *Picks*. They must also be deep sunk in the *Matrices*, lest the Bottom Line of a Page should *Beard*; and the *Beard* must also be well cut off by the *Letter Founder*.

There must be provided also *Brass Rules* of about 16 Inches long; for the *Compositor* to cut into such Lengths as his Work requires: These *Rules* must be exactly *Letter high*; for if they are much too high they cut thro' the Paper, *Tympan*, and *Blankets*: And if but a little so, their *Shoulder* or *Beard* will print black; and they will also bear the *Platten* off the *Letters* that stand near them, so that those *Letters* will not Print at all; and if they be too *Low*, then the *Rules* themselves will not Print. These *Rules* must also be straight all their whole Length: Their Edges of equal Breadth, and neither too thick nor too thin: and the *Brass* should be very well *Planished*, that it may be stiff and strong.

#### Of Cases.

What they call a pair of *Cases* is an *Upper* and a *Lower one*: They are usually both of equal Length, Breadth and Depth, viz. 2 Foot 9 Inches long, one Foot 4 Inches and  $\frac{1}{2}$  broad, and about one Inch and  $\frac{1}{4}$  deep besides the bottom Board. These *Cases* are encompassed with a *Frame* about  $\frac{1}{4}$  of an Inch broad; that the Ends of the several Partitions may be let into the Substance of the Frame: But the hithermost Side of the Frame is about  $\frac{1}{2}$  an Inch higher than the other Sides, that when either the *Galley*, or another pair of *Cases* are set upon them, the Bottom edge of the *Galley*, or of these *Cases* may stop against that higher Frame and not slide off. Both *upper* and *lower Case* have a thick Partition about  $\frac{3}{4}$  of an Inch broad; but the Divisions for the several *Boxes* of the *upper* and *lower Cases* are not alike: For each half of the Length of the *Upper Case* is divided into 7 equal Parts, and its Breadth into 7 also; so that the whole makes 49 Boxes. But the two half Lengths of the *Lower Case* are divided each into 8 eight equal Parts, and its Breadth into 7: And yet not throughout so neither, but the *Lower Case* hath 4 several Sizes of Boxes.

These *Cases* should be placed in good substantial *Frames*; which should be so placed with an *easy Declivity*, that the *Compositor* may the better see and come at his Letters.

#### Of the Galley.

These *Galleys* are of different Sizes according to the Page to be composed. They are commonly made of 2 Flat wainscot Boards each of  $\frac{1}{4}$  or  $\frac{1}{2}$  of an Inch in Thickness: The uppermost to slide in Grooves of the Frame close down to the undermost. The 3 Sides of the Frame are fixed fast and square down on the upper Plain of the undermost Board, to stand about  $\frac{2}{3}$  of the height of the Letter above the Superficies of the *Slice*.

The Sides of the Frame must be broad enough to admit of a pretty many good strong *Oaken Pins* along the Sides, to be drove hard into the bottom Board, and almost quite through the Sides of the Frame, that the Frame may be firmly fixt to it; but they must not be *glewed*; because the *Compositor* may have sometimes Occasion to wet the Page in the *Galley*.

#### Of the Correcting Stone.

This Stone is made of *Marble*, *Purbeck*, or any other Stone that may be made flat and smooth: It should be capacious enough to hold two *Chases* or more; that the *Compositor* on Occasion, may set some Pages by on it ready to *Impose*, tho' two *Chases* lie on the Stone: So that it may be about 2 Foot broad and 4 and a half Feet long. It must be placed on a strong Frame like a Table about 3 Foot one Inch from the Ground or Floor.

#### Of Letter Boards and Paper Boards.

*Letter Boards*, are to lay the Letters on, and are oblong Squares; about 2 Foot long, 18 Inches broad, and 1 Inch and  $\frac{1}{4}$  thick: These should be made strong, and clapt on the under side with-



in about 4 Inches of either End with Pieces of about 2 Inches square, as well to keep them from warping, as that the *Compositors* may easily take them to remove them. *Paper Boards* are only to set Heaps of *Paper* on, and to press the *Paper* with.

#### Of Furniture, Such as

*Head-sticks*, &c. must be made of dry Wainscot, that they may not shrink when the Form stands by; they are Quadrate High, Straight, and of an even Thickness all their Length; and both these and *Side-sticks* are called *Riglet*, if they are not above an Inch in Thickness.

*Side-sticks*, and *Foot-sticks*, are of the same height with the *Head-sticks*; the latter serving to determine the Breadth, at Bottom and Top; as the *Side-sticks* do the length of each *Page*.

*Gutter-sticks*, are used to set between *Pages*, on either Side the Crosses, as in *8vos*, *12mos*, *16mos*, and Forms upwards.

There are *Quoins* also used to lock up the *Forms*, or wedge them so close together (with a *Mallet* and *Shooting-stick*) both on the Sides and Head and Foot of the *Page*, that every *Letter* bearing hard against every other *Letter*, the whole *Form* may *Rise*. As you will see hereafter. The *Shooting-stick*, should be of Box, and is of a wedge-like Shape and of about 6 Inches long.

There is also a *Dressing-Block*, usually made of Pear-Tree, about three Inches square and an Inch high; its use is by being run over the Face of the *Form*, and gently knockt there with the Head of the *Shooting-stick*, to press down such *Letters*, as may happen to stand higher than the rest.

#### Of the Composing-Stick.

This is made of a thin Iron Plate, about 10 Inches long and doubled up square so as that the bottom may be  $\frac{1}{2}$  an Inch and  $\frac{1}{8}$  broad, and the Back about an entire Inch broad. At the further End of the Iron Plate so doubled up, is soldered on an Iron Head which must stand square to the Bottom, about the thickness of a *Long Primmer*: But all its outer Edges are bafil'd and filed away into a moulding. About 2 Inches from this Head and in the Bottom, is begun a Row of round Holes about an Inch asunder to receive the Shank of the *Male Screw*, that Screws the *sliding Measures* fast down to the Bottom: So as these sliding Measures may be set nearer or further from the Head, as the measure of the *Page* requires.



In the Figure annexed *a* is the Head of the *Composing-Stick*, *bb* the Bottom, *cc* the Back, *d* the *Lower Sliding-Measure* or Check, *e* the *Upper Sliding-Measure* or Check, *ff* the *Male Screw*, *g* the *Female Screw*.

The *Lower sliding Measure* is a pretty thick Iron Plate, as broad as the Inside of the Bottom; about 4 Inches in length: And in its Middle is a Groove,

quite thro' it, within about half an Inch of each End, to receive the Shank of the Screw.

On the fore End of this Plate stands square another Iron Head about a *Brevier* thick, and reaching as high as the Top of the Back. The *Upper sliding Measure* is made just like the *Lower*, only  $\frac{3}{4}$  of an Inch shorter. Between these two *sliding-Measures*, they can compose *Marginal Notes* to any Breadth.

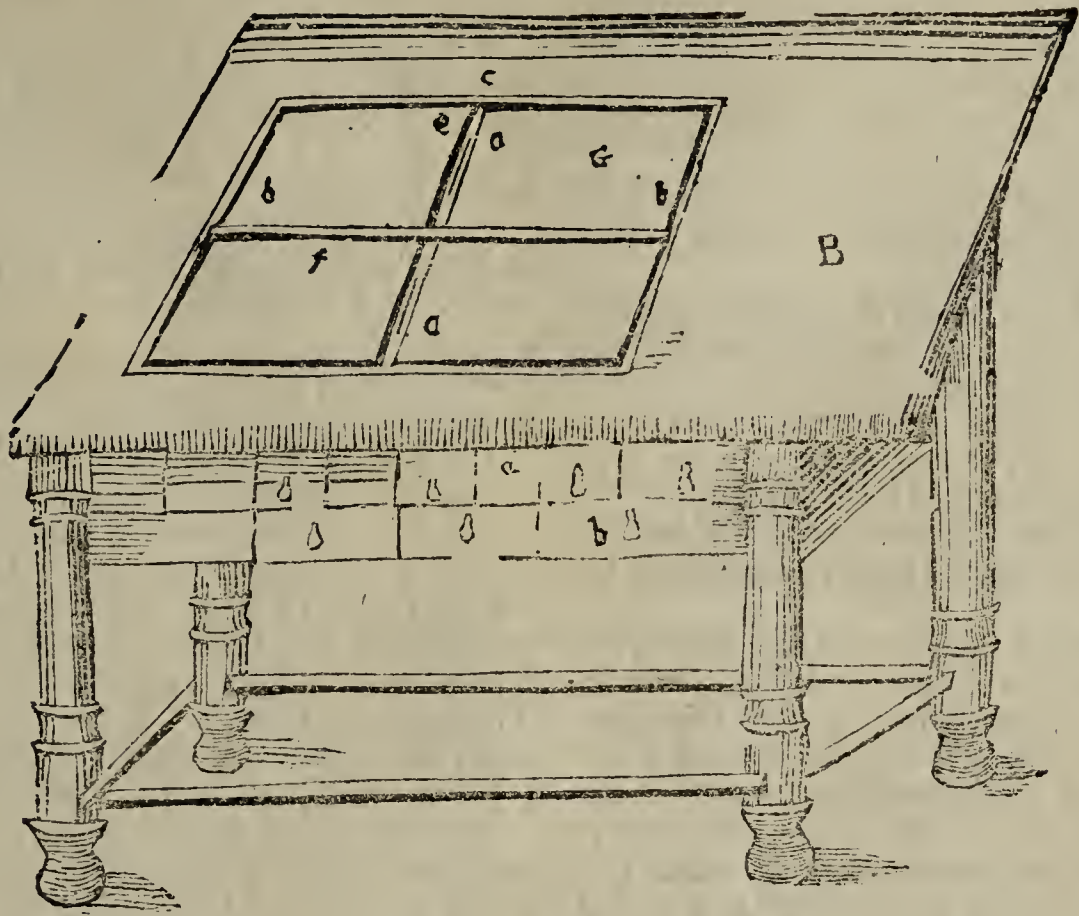
The *Compositor* uses a Bodkin of Steel of about 2 Inches in length from the Shank of the Handle: the Handle is of soft Wood; that when 'tis knockt on the Face of any single *Letter*, which happens to stand too high, it may not batter it.

#### Of Chases.

These are Iron Frames about 22 Inches long, 18 broad, and  $\frac{1}{2}$  Inch and  $\frac{1}{8}$  thick, and the breadth of the Iron on every Side is  $\frac{3}{4}$  of an Inch usually, but it should be an entire Inch: All the Sides must be truly square to one another; that when 'tis laid on the *Correcting Stone*, it may lie truly flat, and the out and inside must be filed straight and smooth. Each *Chase* hath two Crosses belonging to it: One *Shorter* than the other; they are square to one another and are called the *Short* and *Long Cross*. They have at each End a male Dove-tail filed bevil-way from the under to the upper side of the Cross, so that the under side of the Dove-tail is narrower than the upper: These *Male-dove-tails*, are fitted into *Female ones*, filed in the Inside of the *Chase*; and which are also wider on the upper Side of the *Chase*, than on the under, that the upper Side of the *Cross* may not fall thro' the lower Side. The *Short-Cross* is thus dove-tailed into the Middle of the two long Sides of the *Chase*; and the *Long-Cross* into the Middle of the two other Sides. The *Short-Cross* is moveable also in the *Chase* about 3 Inches and a  $\frac{1}{2}$  from the Middle. The Middle of these two *Crosses*, are filed or notched half Way thro', one on its upper, the other on its under Side, that they may be let into one another, and in the Middle between the two Edges of the upper Side of the *Short-Cross* are made two Grooves parallel to the two Sides of the *Cross*, beginning at about two Inches from each End: They are  $\frac{1}{2}$  an Inch deep all the Way, and about  $\frac{1}{4}$  of an Inch broad, that the Points may fall into them. The *Short-Cross* is about  $\frac{3}{4}$  of an Inch thick; and the *Long* about half as much.

See their Figure as they lie on the *Correcting-Stone*.

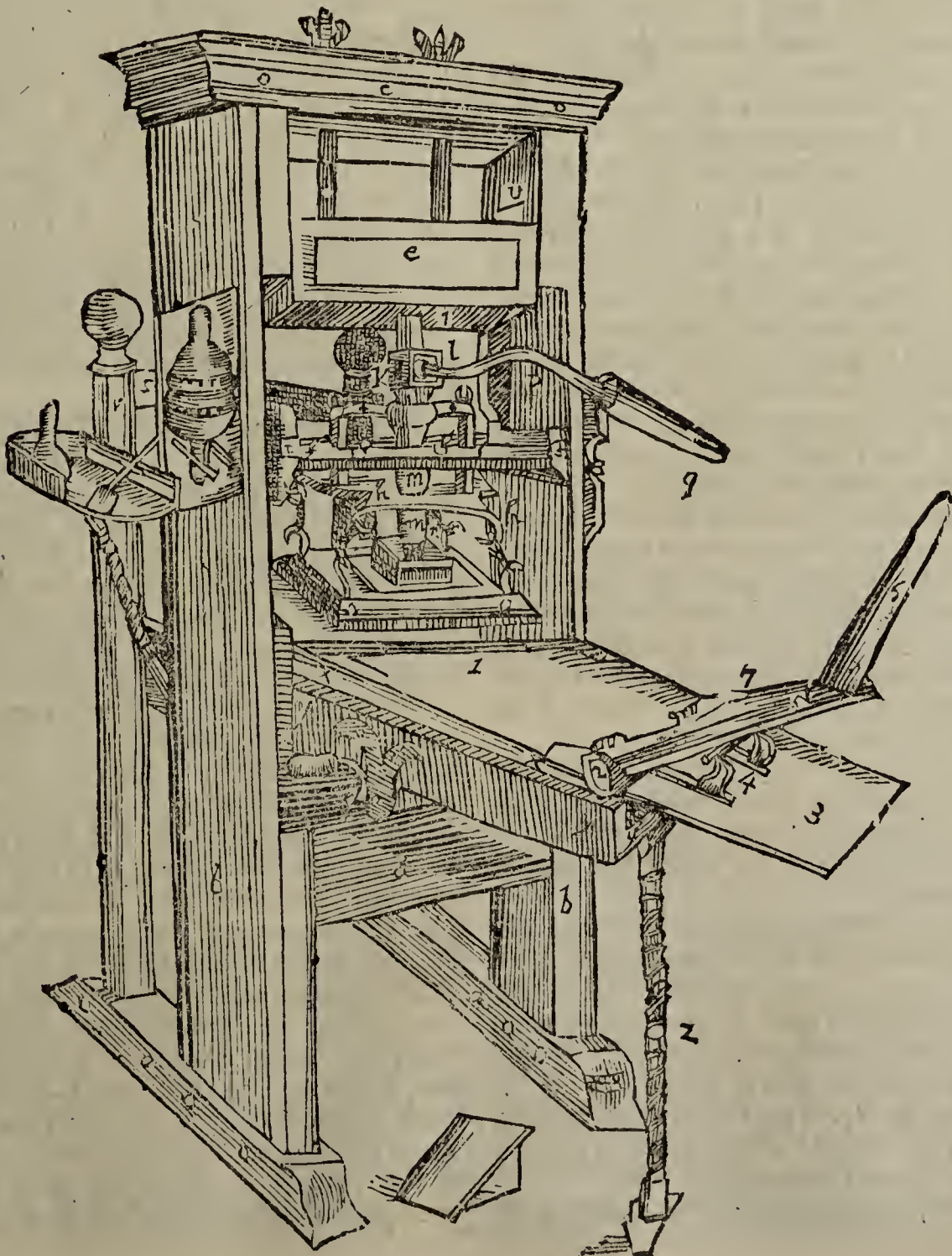




Of the *Press*.

The Printing-Press, whose Figure is here annexed, was invented by the famous *Willem Jansca*

*Bleau*, of *Amsterdam*; who was eminent not only for his good and great Printing, but also for his Globes and Geographical Maps and Charts.





'Tis called the *New Press* by *Moxon*, who saith, it was (in 1683) but little known in *England*, but generally used in *Holland*, and is much better and more commodious than the common *Printing-Press*.

*aa*, Represent its *Feet*, which are 2 Feet 9 Inches and a  $\frac{1}{2}$  long, 5 deep, and 6 broad, having their Outfides truly square.

*bb*, Are the *Cheeks*, which are 5 Foot 10 Inches long, besides the Tenons of the Top and Bottom, 8 Inches broad, and 4 and a half thick.

*d*, Is a Plank called the *Winter*, which is in Length besides the Tenons, a Foot 9 Inches  $\frac{1}{4}$ , in Breadth 8 Inches, and its Depth 9 Inches.

*c*, Is the *Cap*, or Top of all the Press, being 3 Foot and 1 Inch long, 4  $\frac{1}{2}$  Inches deep, and 9  $\frac{1}{2}$  Inches broad.

*e*, Is the *Head* of the Press; whose length, besides the Tenons, is 1 Foot 9  $\frac{1}{4}$  Inches, Breadth 8  $\frac{1}{2}$  Inches, and Depth 8 Inches. Its Top, Bottom, and hind Sides are all square; but the Fore-side projects half an Inch over the Range of the Foresides of the *Cheeks*: In which Projecture is cut a Table with an hollow *Moulding*, about it 2 Inches distant from all the Sides of the Fore-side of the *Head*; its Tenons are 3 Inches broad, and are cut down at either End, from the Top to the Bottom of the Head, and made fit to *Mortices* in the *Cheeks*, that may slide right, and yet play in them.

In the Under-side of the *Head* is cut a Hole about 4 Inches square, and 3  $\frac{1}{2}$  deep, into which a *Brass Nut* is fitted, for the *Worm* to play in.

*i*, Is Part of the *Worm* below the Head; the upper Part being hid in the *Brass Nut*.

*j, k, l, m, n*, Is the whole *Spindle*.

*f*, Is the *Till*, a board about an Inch thick, one Foot 9  $\frac{1}{2}$  long besides the Tenons, its Breadth 8 Inches; in its middle is a round Hole for the Shank of the *Spindle*, and at 7  $\frac{1}{4}$  Inches from each End is a square Hole for the Hose to pass thro'.

*gg*, Are the *Hose*, being upright Irons of  $\frac{3}{4}$  of an Inch square, and at each End have *male Screws* on them. Their lower ends are fastened into the *Hose-hooks*, and their upper Ends into the *Garters* or *Curts*, which is a round Hoop placed over the flat Neck of the Shank of the *Spindle*.

*hhhh*, are the *Hose-hooks*, or the *Hooks* of the *Hose* the Platten hangs on; they proceed from 2 Branches of an Iron Hoop encompassing the lower End of the *Spindle*, on either Corner of the Branch.

*k, l*, Is the *Eye* of the *Spindle*, as *m* is its *Shank*, and *n* its *Toe*; the *Spindle's* Length in all is 16  $\frac{1}{2}$  Inches, the Length of the Cylinder the *Worm* is cut on is 3  $\frac{1}{4}$  Inches, and its Diameter 2  $\frac{1}{4}$ .

*oooo*, Is the *Platten*, tied on to the *Hooks* of the *Hose*; this is usually made of beaten Plank 2 Inches and a half thick, 14 long, and 9 broad; its Sides are tied square, and its under side exactly plain and smooth.

In the middle of its upper side is let in and fastened an Iron Plate called the *Platten-Plate*,  $\frac{1}{4}$  of an Inch thick, 6 Inches long, and 4 broad; in the middle of this Plate is made a square Iron Frame of about half an Inch high, and as much broad; into which is fitted the *Stud* of the *Platten-pan*, so as it may stand steady. This *Stud* is about an Inch thick, and then spreads wider and wider to the Top, where 'tis two Inches and a half.

*p*, Is the *Bar*, in length about 2 Foot 8 Inches, 'tis

fastned strongly with a Nut and Screw into the Eye of the *Spindle*. About 4 Inches from the Shoulder, this Bar is bowed with an obtuse Angle, that the *Press-Man* may the more easily and readily catch at it, to draw its wooden Handle *q* within his reach.

*rr*, Are the *Hind-posts*, which stand at a Foot Distance from the hind sides of the *Cheeks*; they are 3 Foot 4 Inches long besides the Tenons, and 4 Inches thick, and square every way. These hind Posts have six Rails fitted to them, and marked *ss*, and called the *Hind-Rails*.

*tt*, Are the Wedges of the *Till f*.

*uu*, The *Mortices* of the *Cheeks b b*.

*xxxx, yy*, Express the *Carriage*; whose Plank is of *Elm* an Inch and half thick, 4 Foot long, and 1 Foot 8 Inches  $\frac{3}{4}$  broad. On this Plank at its fore end is firmly nailed down a square Frame 2 Foot 4 Inches long, 1 Foot 10 Inches broad, and the Thickness of its sides 2  $\frac{1}{2}$  Inches square. This is called the *Coffin*, and is marked with the Figure (1) in the Plate, and in it the *Stone* is bedded.

(1) On each of the 4 Corners of the *Coffin* is let in and fastned down a square *Iron Plate*, with return-sides about 6 Inches long, each side 1 8th of an Inch thick, and 2 Inch. 1 qr. broad.

Behind this *Coffin* is nailed on to its Outside a *Quarter*, of about 3 Inches longer than the Breadth of the *Coffin*; it hath all its sides 2 Inches over, and 3 of them square: But its upper side is hollowed round to a Groove or Gutter to an Inch and half over. This *Gutter* is so nail'd on, that its hither End standing about an Inch higher than its further End, the Water that descends from the *Tympan* (5) falling into it, is carried on the farther side of the *Coffin* by the Declivity of the further End of the *Gutter* (2,) and so keeps the Plank of the *Carriage* neat and clean, and preserves it from rotting. Parallel to the outward sides of the hinder part of the Plank of the *Carriage* at 3 Inches distance on either side, are nailed two Female Dove-tail Grooves, into which are fitted, so as to slide, two Male Dove-tails made on the two Feet of the Gallows (4) on which the *Tympan* rests.

At 3 Inches from the hinder Rail of the *Coffin* in the middle of the Plank is cut a Hole of four Inches square, and on the hither and further side of this Hole is fastned down a *Stud* of Wood, one on each side, and in the middle of these two Studs is a round Hole of about an Inch over, to receive the two Iron Pins of a wooden *Rowler*, or *Barrel*, with a Shoulder on each side of it to contain so much of the Girt as shall be rolled upon it.

The *Tympan* (5) is a square Frame having 3 of its Sides Wood and one of Iron. 'Tis 2 Foot 8 Inches wide, 2 Foot 2 Inches long, and the Breadth of the wooden Sides an Inch and half, and the Depth one Inch on its hinder end; at the 2 Corners is riveted an Iron *Match Joint*, to be pinned on to another half Joint, fastned on the hind Rail of the *Coffin*. The fore end of the *Tympan* is of Iron, with a square Socket at either End for the wooden Ends of the *Tympan* to fit and fasten into; on the outer Edge of this Iron about an Inch and half from its Ends are made 2 Iron half Joints, to contain a Pin, which entering this, and a *Match half Joint*, made on the Frisket, (6,) serves for a Frisket to move truly upon. In the middle of each long Rail of the *Tympan* is a Hole half an Inch square, for the square Shanks of the *Point Screws*, (7, 8) to fit into.



into. Within the Tympan, which may be called the *Outer*, is another called the *Inner Tympan*, which is fitted exactly to it, and gaged by an Iron Pin, an Iron *Turning-Clasp*.

I hope this Description may serve to make the Figure a little Intelligible, and to give a general Idea of the *Printing-Press*; but no words can possibly explain it so well, as once seeing of it work will do.

I shall omit describing the manner of making the *Types* or several sorts of *Letters*, used in Printing; but whosoever hath a mind to satisfy himself further may consult Mr. *Moxon's* Book of Printing, where he will find the whole affair very largely and plainly described.

I shall only add something further about the Rules and Methods of *Distributing* and *Composing*.

After the *Press-man* hath wrought off as many Sheets from a *Form*, as he is appointed; he first washes the *Form*, and brings it to a place which they call the *Rinsing-Trough*, and rears it a little aslope on one end of the *Chase*; for when 'tis so placed the *Face* of the Letter is less liable to damage, and the *Form* stands in a proper position for the *Compositor* to rear a *Letter Board* against the Back-side of it; by which he raises it up, and then sets the *Letter Board*, and *Form* both a little aslope in the *Rinsing-Trough*. Next with his *Mallet* and *Shooting-stick* he *Opens* or *Unlocks* (as they call it) the *Quoins* and *Form*; and then the Furniture; viz. the *Head-sticks*, the *Inner-Side-sticks*, and *Gutter-sticks*, if the *Form* have any, that he may have the more Room to open the Letter in order to its receiving the Water the more plentifully; which is thrown on it by dish fulls to Rinse and Clean it, and the *Face* of the Letter is rubbed with the Fingers, and shook so that the Water may get between the Letters to clean them; and this is done till the Water thrown and rubbed on, runs away quite clear and colourless. Then he thrusts the Letter and Furniture close up together again that the Letter may not *Squabble*, as they call it, that is, break and fall asunder: after it hath stood a while to dry; he carries *Letter Board*, *Form* and all to the *Distributing frame*: and there he *strips* it of its Furniture, Quarter by Quarter, taking out the *Quoins*, &c. and then with his *Distributing-stick* or *Riglet*, he takes up out of the *Form* as many *Lines* of Letter as he can, and turning their Face towards him, he carries them to his *Casse*, and taking out the Letters, &c. one by one, but very quick and nimbly, he *distributes* each of them to its proper Box in the *Casse*. Then he proceeds to *take off* and *distribute* another parcel, and so goes on till he hath done, or till his *Casse* is full.

They usually choose to distribute their Letter over Night, that they may have a *Dry Casse* to work on in the Morning, for wet Letters are less easy to take up, and besides the Lye makes their Fingers sore.

The *Compositor* next sets himself to the *Composing-work*; and here he must first Determine his *Measure*; to which he fits his *Composing-stick* (above described) by loosening the Screw, and Sliding the Cheeks nearer to or further from its head.

Having fitted his *Measure*, he Places the *Galley* on his upper *Casse* on the Right-hand, and placing his Copy before him, he reads *five* or *six words* or *ten* a part of it as he can keep in his mind, and then spells it over Letter by Letter, taking up the

proper Letters out of their respective *Boxes* in the *Casse*: he sets a *Space* between every Word till they come to the end of the Line; but there none. He holds his stick in his left Hand, and with his Thumb gently presses the Letters close to the *cheek*, keeping it secure, tight and close together, as with his right-hand he puts them into the Stick successively. And 'tis a very surprizing thing to see how very quick this work is performed; and how in an instant he Spells, resolves upon, and takes out the several Letters which compose his Work, and supply his Stick.

Having composed one Line; if it ends with a *Word*, or a *Syllable* and a *Division*, and just fill the *Measure*, then it needs no more *Justifying* as they call it, the *Stick* being duly filled; but if the Line conclude not so, then he puts a *Space* more between every Word, or at least so many as will fill up the *Measure* pretty Stiff, or *justify* the Line. And here he takes care that his Letter don't *Hang*, as they call it, *i. e.* Stand a-skew.

After he hath thus composed one Line, he begins another, and so goes on till his Stick be full; and when it is so, he empties it, laying it down on his *Lower-Casse*, and by means of a *Riglet* of just the Length of the Line, he claps it down into the *Galley*, placing the first Line close and upright against the lower Ledge of the *Galley*.

As he *Sets* or composes this first Stick of Letter, so he goes on till his Page is out, remembering after the last Line of every Page to set a *Direction*; that is, he sets a Line of *Quadrates* and at the End of it the first Word of the next Page, or if the Word be very long and the Line very short, two Syllables, or sometimes but one, of that Word. And when 'tis the first Page of a Sheet, he sets a *Signature* as they call it (*i. e.*) *A* for the first Sheet, *B* for the Second, &c. And so successively till he come to *W* which is always skipt, because the Latin Alphabet hath no such Letter.

When our *Compositor* hath got a full Page in his *Galley*, he next ties it up fast together with a Pack-thread, or Cord, according to the bigness of his Letter and Page, and then carries it to the *Correcting-Stone*, and here all the Pages which belong to a Sheet, with the *Chase* and *Furniture* about them, are duly placed, or *Imposed* as they call it: that is, so disposed or ordered, as that when the Sheet comes to be wrought off at the Press, all the Pages may be folded into an orderly Succession. And the four different Volumes of *Folios*, *Quartos*, *Octavos*, and *Twelves*, are all diversly *Imposed*.

#### Correction.

In *Correcting* Faults, if there be but a few of them, and these *Easy* ones, the *Compositor* gathers the Corrections in his *Stick*, beginning at the bottom of every Page and so ascending: because when he is *Correcting*, the Corrections of the Top of the Page stand the *first* in the *Stick*, and therefore are readiest to his hand.

But if there be many and considerable Faults, he brings the *Lower Casse* to the *Correcting-Stone*, and takes his *Corrections* as he uses them. Then he *unlocks* the *Form*, but keeps the *Quoins* pretty tight up, lest his Letter should *hang* or *squabble*; and there folding the Proof, so that the *Head-line* in it may lie in the same Range with the *Head-line* of the Metal, &c. so that all the Lines in the *Proof* coincide



coincide or range right with the respective ones in the Metal; by running his Eye along easily the several Places, or Lines in the Proof, where the *Corrector* had mark'd a Fault; he as easily mends it in the Corresponding Line in the *Letter of Metal*.

If there be a *Long* word or more than one left out, the *Compositor* is usually forced to *over-run*, as they call it: *i. e.* he must put so much of the forepart of the Line, into the Line above it; or so much of the hinder-part of the Line into the next Line under it, as will make Room for what is left out.

If much be left out, he must *over-run* many Lines either backwards or forwards, or both, till he come to a *Break*; and when he comes thither, if it be not *Gotten in*, as their Word is, then he is forced to *Drive out* a Line; and sometimes to get in that Line, he is forced to over-run the next Page backwards or forwards, till that Line can come in.

The Quite contrary Process must he take, if he happen instead of *Leaving out*, to set any thing *twice over*: for if it be but little he must take it out, then *Drive out* his *Matter*: But if it be as much as two or three Lines, &c. then he must over-run the next Page, or more, and sometimes the whole Sheet, till it be *Driven out*.

After all this Correcting there is, or always should be a *Revise*, to see that the Faults are truly mended; and if not, to have them *Re-Corrected*, by unlocking either the whole *Form*, or only that Quarter of it where the Faults are, &c.

And because 'tis a Thing very useful for all Authors, and Correctors of Printing presses to be acquainted with, I shall conclude this Account of Printing with proper Directions for both.

And first the Author should well examine his Copy before it go to the Press; and *Point* and *Mark* it so, as that the *Compositor* may know what Words to Set in *English*, *Italick*, *Capitals*, &c. For his *Italick* Words, he should draw a Line under them *Thus*: for English Words two Lines *Thus*: and

for Capitals a Line of Points *Thus*, or else a Line

with Red Ink. If there are no Proper *Breaks* made in the Copy; the Author must supply them by a Crochet [*Thus*, before the word he would have begin his new Paragraph.

And every Author, if he can possibly, out of a due regard to his own Reputation, which else may much suffer, or at least as much as he can, will correct the *Sheets* of his Book himself; that is, look them over, after the Printers *Corrector* hath mended the common Typographical Faults: And whether it be the Author himself, or some other *Corrector*, that hath this Care upon him, the Way of correcting Faults so as they may be mended by the *Compositor* is after this manner.

When one Letter is put instead of another, as in this word *Tho* for *The*; he dashes out the wrong

e] Letter thus *The*, and Writes the *Letter* it should be on the Right Hand *Margin* of the *Page*, right against the same *Line*, and makes a Dash behind it, as you may see in the *Margin*.

al c] If two three, or more Words in the same *Line* have *Faults* in them as in these Words, *Potienye*

peg force; where first an o is Set instead of a, e instead of c, t instead of r, and c instead of o: These he marks in an orderly succession towards the Right Hand, against the same *Line*, as you may see in the *Margin*.

But if one word be set instead of another, as *Scoff* instead of *Smile*, here he marks *Scoff* out thus *Scoff*, and writes *Smile*, as in the *Margin*.

If a *Word* or *Words*, or *Letter* or *Point* be *Left out*, he makes this mark A, where it is *Left out*, for a mark of Insertion, and Writes in the *Margin* what must come in.

If a *Space* be *Left out*, he makes the former Mark of Insertion where it should come in, and makes this mark H in the *Margin*.

If a whole Sentence be *Left out*, too long to be Writ in the *Margin*, he makes the Mark of *Insertion* where it is *Left out*, and only Writes (Out) in the *Margin*. If the Sentence *Left out* be not very long, he Writes it under the *Page*, or on the Left Hand *Margin* of the *Page*: But if it be too large to be Writ in the *Margin*, or under the *Page*, he Writes in the *Margin*, See the Copy.

If a Word or Sentence be Set twice; as *Him Him*, he marks out one *Him* thus *Him*, and makes this mark S in the *Margin*, for *Dele*, to take out.

If a *Letter* be turned thus A, he dashes it out as you see, and makes this Mark in the *Margin*.

If Words are *Transposed*, that is, if one Word stand in another Words place, as, no I love Swearing, and it should be, I love no Swearing: he marks this *Fault* thus, no | I love Swearing, and makes this Mark M in the *Margin*. The like Mark he makes in *Matter* and *Margin* if two Letters are *Transpos'd*.

If a *Space* or an m or n *Quadrate*, &c. stick up and *Print Black*, as between these Words, he marks in the *Margin* thus.

If a *Word* be set in *Roman Letter* instead of *Italick* or *English Letter*, he dashes the Word underneath thus, and Writes *Ital.* or *Eng.* in the *Margin*.

In like manner, if a single *Letter* or more *Letters* be Set in *Roman Letter*, and it should be *Italick* or *English Letter*; or if in *English* or *Italick*, and it should be *Roman Letter*, he dashes the *Letter* or *Letters* thus underneath, and writes *Ital. Rom. Ital|Rom|Eng* or *Eng.* in the *Margin*: Or if *Lower Case Letters* be Set instead of *Capitals*, he dashes them underneath, and Writes *Capt.* in the *Margin*.

r] ol

Smile,

#]

(Out)

(See the Copy)

9

H

M

[

Ital|Eng|

Capt

Having



Having Read the *Matter* of the *Proof* he examines again if the *Form* be right *Impos'd*, for though he before turn'd the *Pages* in the *Proof* as he read them accordingly to their orderly places, yet he will scarce trust to that alone, but again examines them on purpose, and distinctly, which he does not only by the *Direction Word*, but by examining the whole Sentence the *Direction* comes in, both at the end of the *Page*, and the beginning of the next *Page*.

He examines that all the *Signatures* are right, and all the *Titles* and *Folio's*.

If the *Work* be large *Forms* and small *Letter*, he has a *Second*, and sometimes a third *Proof*, which he reads as the first.

After the *Second* or *Third Proof* he has a *Revise* which is also a *Proof-sheet*: He examines in this *Revise* Fault by Fault, if all the *Faults* he markt in the last *Proof* were carefully mended by the *Compositor*; if not, he marks them in the *Revise*.

**PRINTS.** The Original of *Prints* or *Cutts*, as we sometimes call them, was this; in the Year 1460, one *Maso Finiguerra*, a Goldsmith of *Florence*, graved his Plate; and then casting some of it in melted Brimstone, he perceived, that what came out of the Mold was markt with the same Prints as his Plate, by the Black which the Sulphur had taken from the Graving: after this he tried to do as much on Silver Plates with wet Paper, by rolling it smoothly with a Roller, and this succeeded. This Novelty tempted *Baccio Baldini*, a Goldsmith of the same City, to attempt the same thing, which he did with Success; engraving several Plates of *Sandro Boticello's* Invention and Design; and upon this *Andrew Mantegna*, who was then at *Rome*, set about engraving some of his own Pieces. This knowledge getting into *Flan-ders*, *Martin of Antwerp*, a famous Painter, graved abundance of Plates of his own Invention, and sent several Prints into *Italy*, which were markt thus, *M.C.* After him the Famous *Albert Durer* appear'd and gave the World a vast Number of Prints, both in Wood and Copper. About this time one *Hugo de Carpi*, an *Italian* Painter of no great Capacity, but of a ready Invention, found out a way, by means of several Plates of Wood, to make Prints resemble Designs of *Claro-Obscuro*: and some Years after the Invention of *Etching* was discovered, which was soon made use of by *Parmeggiano*.

**PRIORITY**, in Law, signifies an Antiquity of Tenure, in comparison of another not so ancient; as to hold by Priority is to hold of a Lord more anciently than of another.

**PRISAGE**, is that Custom or Share that belongs to the King, out of such Merchandises, as are taken at Sea by way of Lawful Prize.

**PRISM**, is a solid Figure, contained under several Planes, whose Bases are Polygons, equal, parallel, and alike situated. Also a Triangular solid Glass, thro' which the Sun's Rays being transmitted are refracted into the vivid Colours of the Rain-bow.

The Surface of a Right *Prism*, is equal to a Parallelogram of the same height, having for its Base a Right Line equal to the Periphery of that *Prism*. The same may be said of a Cylinder, because it is but a *Prism* of Infinite Sides.

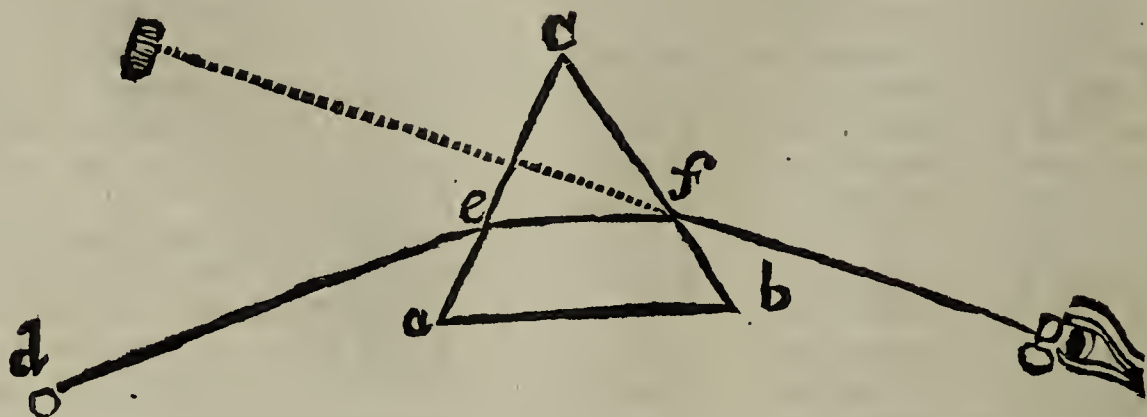
The Solid Content of a *Prism*, is found by Multiplying the Area of its Base by its Perpendicular Altitude.

A *Prism* is a Triple of a Pyramid of the same Base and Height. See *Proportion of Solids*, where 'tis demonstrated.

**PRISM**: A Glass bounded with two equal and parallel Triangular Ends, and three plane and well-polished Sides, which meet in three parallel Lines, running from the three Angles of one End, to those of the other, is called a *Prism*; and is used in Opticks to make many noble and curious Experiments about *Light* and *Colours*; for the Rays of the Sun falling upon it at a certain Angle, do transinit thro' it a *Spectrum* or Appearance, colour'd like the *Iris* or Rainbow in the Heavens. Under the Word *Colours* you have a great Variety of Experiments made with such Glasses, by the Incomparable Sir *Is. Newton*; and from whence, in a good Measure, he hath established his Demonstrative Theory of *Light* and *Colours*; a large Account of which you may find in his *Opticks*.

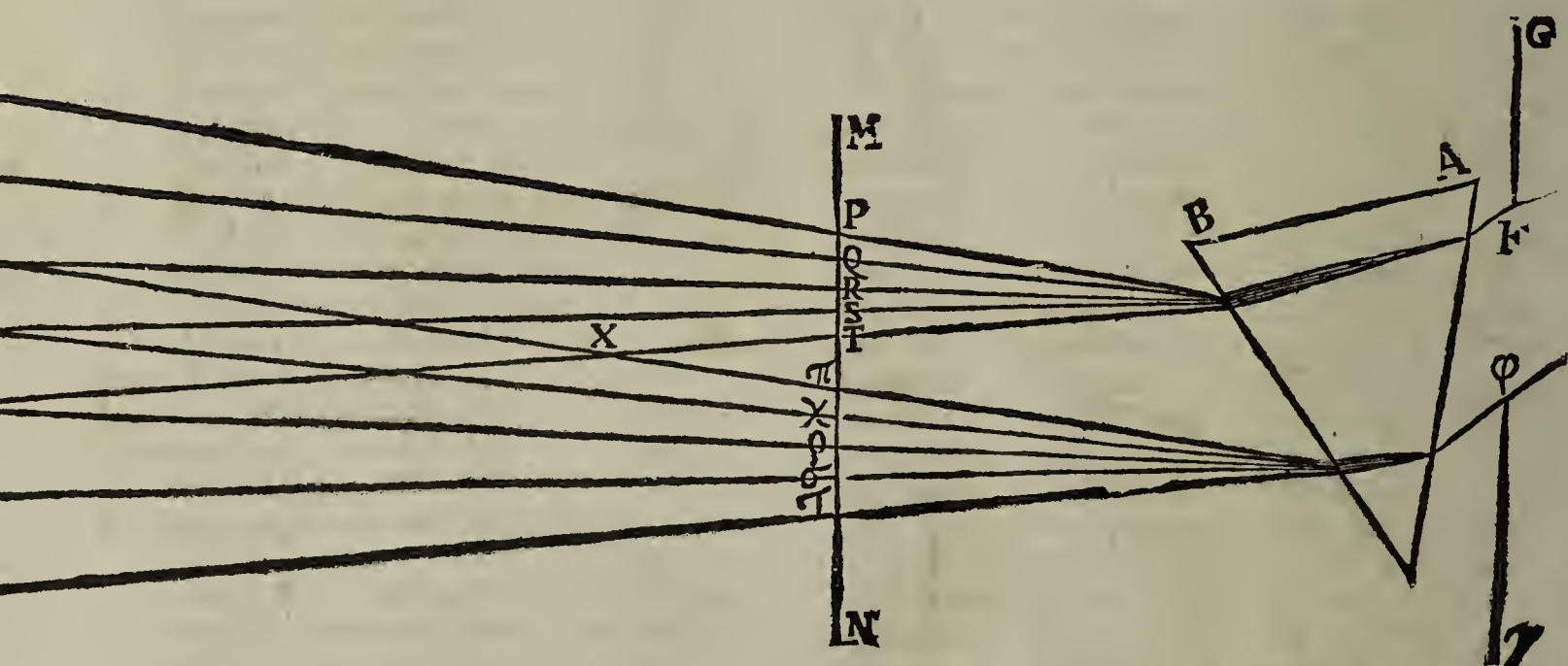
How to find the Refraction of a Ray of Light passing thro' such a Prism, the same Author shews thus: Let *a b c* represent the Section of this Prism made by a Plane passing transversely to three parallel Lines or Edges, then when the Light passeth thro' it; and let *d e* be the Ray incident on the first Side of the Prism *a c*, where the Light goes into the Glass: Then by putting the Line of Incidence to the Line of Refraction as 17 to 11: Find (by the Direction given under the Word *Incidence* in this Volume) *e f* the first refracted Ray; then taking this Ray for the Incident Ray on the second side of the Glass *b c*, where the Light goes out, find the next refracted Ray *f g*; by putting the Ratio of the Line of Incidence to the Line of Refraction as 11 to 17; for if the Line of Incidence out of Air into Glass be to that of Refraction as 17 to 11, the Line of Incidence back again, out of Glass into Air, must be as 11 to 17.





The same admirable Author, *Opticks*, p. 121, shews, how by the Properties of Light discovered

by his most accurate Experiments, to explain the *Phænomena* of Colours made by Prisms; thus,



Let  $abc$  be a Prism refracting the Sun's Light, brought into a darkned Room, by the Hole  $F\phi$ , almost as broad as the Prism; and let  $mn$  be a White Paper on which the refracted Light is cast: And suppose the most refrangible or deepest Violet Rays to fall on the Space  $P\pi$ , the least refrangible or deepest Red Ray on the Space  $T\gamma$ , the middle sort, between the Indico and Blue Rays, on the Space  $Q\chi$ ; the middle sort of the Green Rays on the Space  $R\epsilon$ ; the middle sort between the Yellow and Orange Rays on the Space  $S\sigma$ ; and the other intermediate Sorts on intermediate Spaces. For so the Spaces on which the several Sorts adequately fall, will, by reason of the different Refrangibility of these Sorts be one lower than the other. Now if the Paper  $mn$  be so near the Prism that the Spaces  $P\pi$  and  $\pi\gamma$  do not interfere with one another, the Distance between  $T\pi$  will be illuminated by all the sorts of Rays in that Proportion to one another which they have at their very first coming out of the Prism, and consequently will be White. But the Spaces  $P\pi$  and  $\pi\gamma$  on either hand, will not be illuminated by them at all, and therefore will appear coloured; and particularly at  $P$ , where the outmost Violet Rays fall alone, the Colour must be the deepest Violet. At  $Q$  where the Violet and Indico Rays are mix'd, it must be a Violet inclining much to Indico. At  $R$  where the Violet, Indico, Blue, and one half of the Green Rays

are mix'd, their Colours must (by the Constitution of *Problem 2.* in *pag. 114*) compound a middle Colour between Indico and Blue. At  $S$ , where all the Rays are mix'd, the Red and Orange, thin Colours, ought, by the same Rule, to compound a faint Blue, verging more to Green than Indico. And in the progress from  $S$  to  $T$  this Blue will grow more and more faint and dilute; till at  $T$ , where all the Colours begin to be mix'd, it end in Whiteness.

So again on the other side of the White at  $T$ , where the least refrangible or utmost Red Rays are alone, the Colour must be the deepest Red. At  $\sigma$ , the Mixture of Red and Orange will compound a Red inclining to Orange. At  $\epsilon$ , the Mixture of Red, Orange, Yellow, and one half of the Green, must compound a middle Colour between Yellow and Orange. At  $\chi$ , the mixture of all Colours but Violet and Indico, will compound a faint Yellow, verging more to Green than Orange: and this Yellow will grow more faint and dilute continually, in its progress from  $\chi$  to  $\pi$ , where it will become White by a mixture of all sorts of Rays.

These Colours ought to appear were the Sun's Light perfectly White; but because it inclines to Yellow, the excess of the Yellow Rays, where-with it is tinged, being mix'd with the faint Blue between  $S$  and  $T$ , will draw it to a faint Green. And so the Colours in order from  $P$  to  $T$  ought to

be



be Violet, Indico, Blue, very faint Green, White, faint Yellow, Orange, Red: Thus it is by computation, and they that please to view the Colours made by a Prism will find it so in Nature.

These are the Colours on both sides the White, when the Paper is held between the Prism and the Point  $x$  where the Colours meet, the Interjacent White vanishes: For if the People be still farther off from the Prism, the most refrangible and least refrangible Rays will be least in the middle of the Light, and the rest of the Rays which are found there, will by mixture, produce a fuller Green than before; also the Yellow and the Blue will now become less compounded, and by consequence, more intense than before.

And if thro' a Prism you view a White Object encompassed with Black or Darknes, the Reason of the Colours appearing on the Edges is much the same. If a Black Object be encompassed with a White one, the Colours arising from seeing it thro' a Prism, are to be derived from the Light of the White one, spreading into the Regions of the Black; and therefore they will appear in a contrary order. And 'tis the same when an Object is viewed, those Parts are some of them less or more luminous than others: For in the Borders of the more or less luminous Parts, Colours ought always, on the same Principles, to arise from the excess of the Light of the more luminous, and to be of the same kind as if the darker Parts were Black, but yet to be more faint and dilute.

And what is thus said of the Colours which are exhibited by Prisms, may easily be applied to those Colours which the Glasses of Telescopes and Microscopes, or even the Humours of the Eye produce: For if the Object-Glass of a Telescope be thicker in one part than another; or if one half of the Glass, or one half of the Pupil of the Eye, be covered by an Opaque Body; then that Object-Glass, or its half, or the half of the Eye which is uncovered, may be considered as a kind of *Cuneus* with curved Sides. And every Glass, or Pellucid *Cuneus* (or Wedge) will produce the same Effect as a *Prism*, by refracting the Rays of Light as they are transmitted thro' it.

PRISMOID, is a solid Figure, contained under several Planes whose Bases are rectangular Parallelograms, parallel and alike situate.

PRIVATIVE [in Grammar] a Particle which being prefixed to a Word, changes it into a contrary Sense.

PRIVATIVE Quantity, [in Algebra] is a Quantity that is less than Nothing; which is called also a *Negative Quantity*, in opposition to *Affirmative* or *Positive* Quantities.

PRIVILEGE, is by *Cicero* defined to be *Lex privato homini irrogata*. Others say it is, *Jus singulare*, whereby a private Man, or a particular Corporation, is exempted from the Rigour of the Common Law. It is used sometimes in the Common Law, for a place that hath any special Immunity.

PRIVILEGE, is either Personal or Real: A *Personal Privilege*, is that which is granted to any Person either against or beyond the Course of the Common Law: As for Example, A Member of Parliament may not be arrested nor any of his Servants, during the sitting of the Parliament; nor for a certain Time before and after. A

*Privilege Real*, is that which is granted to a place, as to the *Universities*, That none of either may be called to *Westminster-Hall*, upon any Contract made within their own Precincts, or prosecuted in other Courts. And one belonging to the Court of Chancery cannot be sued in any other Court, certain Cases excepted; and if he be, he may remove it by *Writ of Privilege*.

PRIVY, in Law, signifies him that is partaker, or hath an Interest in any Action or Thing, as *Privy of Blood*, are those that are linked in Consanguinity; every Heir in Tail is *Privy* to recover the Land intailed. The Author of the *New Terms of Law*, maketh divers sorts of *Privies*, viz. *Privies in Estate*, *Privies in Deed*, *Privies in Law*, *Privies in Right*, and *Privies in Blood*. Others mention four kinds of *Privies*, viz. *Privies in Blood*, as the Heir to his Father. *Privies in Representation*, as Executors or Administrators to the deceased. *Privies in Estate*, as he in the Reversion, and he in the Remainder, when Land is given to one for Life, to another in Fee, for that their Estates are created both at one Time. The fourth is *Privy in Tenure*, as the Lord by escheat, that is, when the Land escheateth to the Lord for want of Heirs.

PRIVY-SEAL, is a Seal that the King useth to such Grants, or other things, as pass the *Great-Seal*; first they pass the *Privy-Signet*, then the *Privy-Seal*; and lastly the *Great-Seal of England*. The *Privy-Seal* is sometimes used in things of less consequence, that never pass the *Great-Seal*, no Writs shall pass under the *Privy-Seal*, which touch the Common Law.

PROBATE, of *Testaments*, is the exhibiting and proving Wills and *Testaments* before the Ecclesiastical Judge, delegated by the Bishop, who is Ordinary of the Place, when the party dies. And the Ordinary is known by the quantity of Goods that the deceased hath out of the Diocese wherein he departed; for if all his Goods be in the same Diocese, then the Bishop of the Diocese, or the Archdeacon, according as their Composition leads, hath the *Probate of the Testament*: But if the Goods be dispersed in divers Diocesses, so that there be any Sum of Note (as five Pounds ordinarily) out of the Diocese where the party lived; then is the Archbishop of *Canterbury* the Ordinary by *Prerogative*.

This *Probate* may be made in two sorts, in *Common form* or *per testes*. The *Proof in common Form* is only by the Oath of the Executor or Party exhibiting the Will, who sweareth upon his belief, that the Will exhibited by him, is the last Will and *Testament* of the deceased. The proof *per testes* is when over and besides his own Oath, he also produces Witnesses, or makes other Proof to confirm the same, and that in the presence of such as may pretend any Interest in the Goods of the deceased, or at least in their absence, after they have been Lawfully summoned to see such a Will proved, if they think good. And the latter Course is taken most commonly when there is fear of strife or dispute about the deceased's Goods. For some hold that a *Will proved in common Form* only may be called in Question any Time within thirty Years after: And where a Will disposes of Lands and Tenements of Freehold, it is now frequently proved by *Witnesses in Chancery*.



PROBATOR, in Law signifies an Accuser, or Approver, or one who undertakes to prove a crime charged upon another.

PROBE, a Chirurgical Instrument to sound the Depth and Circumstances of Wounds or Ulcers.

PROBLEM, [*πρόβλημα*, Gr.] in Logick a doubtful Question or a Proposition, which neither appears absolutely true nor false, but which is probable on both sides, and may with equal Evidence be asserted either in the Negative or the Affirmative.

PROBLEM [in *Algebra*] is a Question or Proposition, which requires some unknown Truth to be investigated or discovered, and the Truth of the discovered demonstrated.

PROBLEM, [*πρόβλημα*, Gr.] is a Proposition which relates to Practice; or which proposes something to be done; as to make a Circle pass through three given Points not lying in a Right Line: To find the Compass, &c.

PROBLEMATICAL *Resolution* [in *Algebra*] is a Method of solving difficult Questions by certain Rules called Canons.

PROCATARCHICA, [of *προκαταρχω*, Gr. *to go before*] is the pre-existent Cause of a Disease, which co-operates with others that are subsequent; whether it be external or internal, as Anger, or Heat in the Air, which beget ill Juice in the Blood and cause a Fever. *Blanchard*.

PROCEDENDO, is a Writ whereby a Plea or Cause formerly called from a Base Court to the Chancery, King's-Bench, or Common-Pleas, by Writ of Privilege or Certiorari, is released and sent down again to the same Courts to be proceeded in there, after it appeareth that the Defendant hath no Cause of Privilege, or that the Matter comprised in the Bill is not well proved.

PROCESS, in Law, is the manner of proceeding in every Cause, being the Writs and Precepts that go forth upon the Original upon every Action, being either Original or Judicial. Sometimes that only is called the *Process*, by which a Man is called into the Court, because it is the beginning or principal Part thereof, by which the rest of the Business is directed. The difference between *Process* and *Precept*, or *Warrant* of the Justices, is this, the *Precept* or *Warrant* is only to attach and convene the Party before any Indictment or Conviction, and may be made either in the Name of the King or the Justice: But the *Process* is always in the King's Name, and usually after an Indictment.

PROCESS, in Chymistry, signifies the whole exact Course of any Operation or Experiment.

PROCESSION, in Cathedral and Conventual Churches, the Members formerly had their stated Processions, wherein they walked two and two in their most Ornamental Habits, with Hymns, Musick and other suitable Expressions of Solemnity, and respect to the Occasion. In every Parish there was a Customary *Procession* of the Parish Priest, the Patron of the Church with the Chief *Flag*, or Holy Banner, and the other Parishioners in *Ascension Week*, to take a Circuit round the Limits of the Mannor, and pray for a Blessing on the Fruits of the Earth. To this we owe our present Custom of *Perambulation*, which is still in most places called *Processioning*, and going in Procession, tho' we have lost the Order, and al-

most the Devotion, as well as the Pomp and Superstition of it.

PROCESSUM *continuando*, is a Writ for the continuance of a *Process*, after the Death of the Chief Justice, or other Justice in the Writ of *Oyer* and *Terminer*.

PROCESSUS, *vid. Apophysis*.

PROCESSUS *Ciliaris*. See *Ciliare Ligamentum*.

PROCESSUS *Mammillares*. See *Papillarum Processus*.

PROCESSUS *Peritonæi*, are as it were two oblong Pipes, or Channels, one on each side the *Os Pubis*, reaching to the Skin of the *Scrotum*, thro' the Holes of the Tendons of the Oblique and Transverse Muscles, in which Production or *Didymi*, as the Ancients called them, the Seminary Vessels descend, and bestowing one Tunicle on the *Testes*, they contain them like a Bag. By the Holes of these Processes, the Muscles called *Cremasteres* do also descend.

PROCESSUS *Styliformis*, or *Styloides*, is a kind of External Process of the *Ossa Temporum*, being small and long, having the Horns of the *Os Hyoides* tyed to it, it is a slender and long Appendix, and in Infants is Cartilaginous, but in Adult Persons, Bony.

PROCESSUS *Zygomaticus* or *Fugalis*, is an External Process of the *Ossa Temporum*, which runs forward, and is joined with the Bone of the upper Maxilla, from which juncture is formed that Bridge called the *Zygoma*, reaching from the Eye to the Ear, under which lie the Tendons of the Crotaphite Muscle.

PROCHEIN *amy*, in Common Law, signifies him that is next of Kin to a Child in his Nonage, and is in that respect allowed by Law to deal for him, in the managing his Affairs, as to be his Guardian, if he hold any Land in *Socage*, and in Redress of any Wrong done to him, and is in the Prosecution of any Action at Law *per Guardianum*, where the Plaintiff is an Infant, & *per proximum amicum*, where the Infant is Defendant.

PROCIDENTIA *Ani*, is a falling out of the Lower end of the *Rectum intestinum*, and is very usual in Children.

PROCIDENTIA *uteri*, is a relaxing of the inner Tunick of the *Vagina* of the Womb, and was cut off by Physicians formerly, and even still, some think the Womb it self may fall down; but the Ligaments are so strong as to hinder any such Fall. *Blanchard*.

PROCIDENTIA *Uvulæ* [in *Anatomy*] the Defect or Relaxation of the *Uvulæ*, or Almonds of the Ears. L.

PROCLAMATION, is a Notice publickly given of any thing, whereof the King thinks fit to advertise his Subjects.

PROCLAMATION of a *Fine*, is a notice openly and solemnly given at all the Assizes held in the County, within one Year after the engrossing it. And these Proclamations are made upon Transcripts of the *Fine*, sent by the Justices of the Common-Pleas, to the Justices of Assize, and the Justices of Peace.

PROCLAMATION of *Rebellion*, is a Publick Notice given by the Officer, That a Man not appearing upon a *Subpæna*, nor an Attachment in the Chancery, shall be reputed a Rebel, unless he render himself by a Day assigned in this Writ.



**PROCONDYLI**, [of  $\pi\kappa\delta$  and  $\pi\acute{o}\nu\delta\upsilon\lambda\omicron\iota$ , Gr. *a Finger or Joint*] are the Bones of the Fingers next the back of the Hand.

**PRO confesso**, in Law, is when upon a Bill exhibited in Chancery, the Defendant appears, upon a *Habeas Corpus* (which is granted by order) to bring him to the Bar, the Court Assigns him a Day to Answer; which being expired, and no Answer put in, a second *Habeas Corpus* is granted, and a farther Day assign'd; by which Day, if he answer not, the Bill upon the Plaintiff's Motion, shall be taken *pro confesso*, unless cause be shewed by a Day, which the Court usually gives, and for want of such cause shew'd upon Motion, the Substance of the Plaintiff's Bill shall be decreed, as if it had been confessed by the Defendant's Answer.

**PROCTOR**, is he who undertakes to manage another Man's Cause in any Court of the Civil or Ecclesiastical Law, for his Fee.

**PROCTORS of the Clergy**, are those who are chosen and appointed to appear for the Cathedral and other Collegiate Churches; as also for the Common Clergy of every Diocese at the Parliament, to sit in the Lower-house of Convocation.

**PROCURATIONS**, are a Pecuniary Sum or Composition paid by the Parish Priest to an Ordinary or some other Ecclesiastical Judge, as an Archdeacon, &c. to commute for the Provision or Entertainment which was otherwise to have been procured for him; which Entertainment was called a *Procuracion*.

**PROCURATOR**, is used for one that gathereth the Fruits of a Benefice for another Man; 3 R. II. Stat. 1. cap. 3. as *Procuracy* was the Word for the Instrument empowering him to do it. In the West of England, such Persons are called *Proctors* to this Day. Cowel.

**PROCURATORY**, is the Instrument by which any Person or Community did constitute or delegate their Proctor or Proctors to represent them in any Judicial Court or Cause.

**PROCYON**, [ $\pi\rho\omicron\kappa\upsilon\omega\upsilon\alpha\eta$ ] a fixed Star of the second Magnitude in *Canis Minor*.

**PRODES Homes**: This is a Title often given in our old Books to the Barons or other Military Tenants, who were called to the King's Council; and was no more than *Homines discreti & fideles*.

**PRODROMUS**, [ $\pi\rho\delta\delta\rho\omicron\mu\omicron\varsigma$ , Gr.] a Fore-runner a Harbinger.

**PRODROMUS Morbus**, is a Disease that comes before a greater, as the straitness of the Breast predicts a Consumption, or the Rickets. *Blanchard*.

**PRODUCE**, a Term in Geometry, signifying to continue a Right Line, or draw it out farther till it have any assigned Length.

**PRODUCT**, is the Quantity arising from, or *Produced* by the Multiplication of two or more Numbers, Lines, &c. into one another; thus, If 6 be multiplied by 8, the Product is 48. In Lines, 'tis always, (and sometimes in Numbers) called the Rectangle between the two Lines that are multiplied one by another. See *Rectangle*.

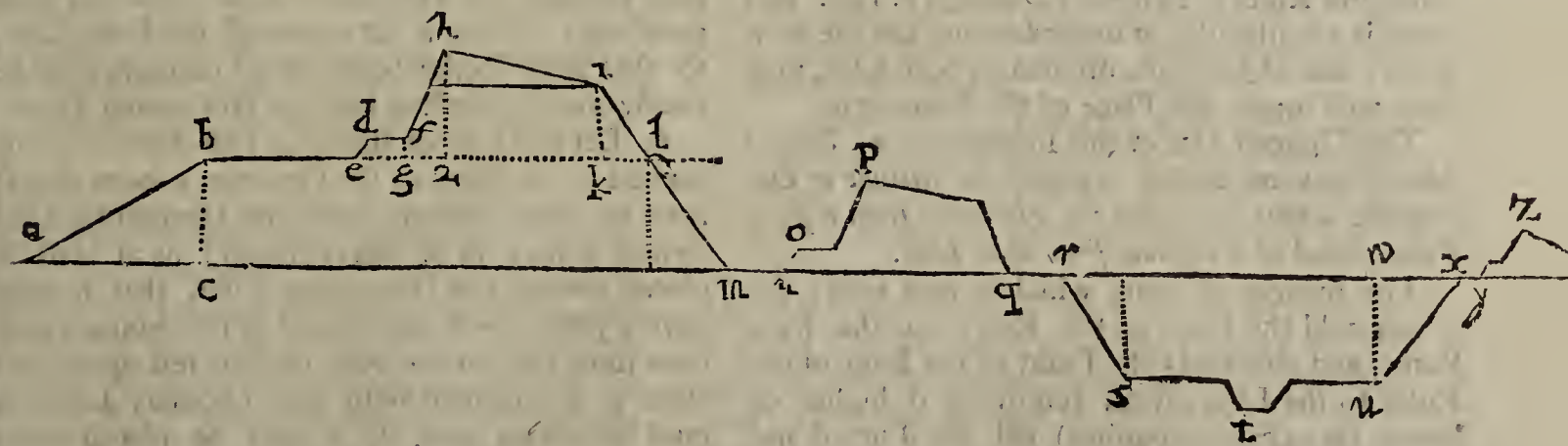
**PROEGUMENA**, is an antecedent internal Cause of a Disease in the Body, occasioned by another, and so causing the Disease, that if it be taken away, the Disease may still continue; as a *Plethora*, or ill Juice in the Blood, produced by an ill way of Diet, whence proceeds an Obstruction of the Entrails. *Blanchard*.

**PROFER**, *Profrum vel Proferum*; is the Time appointed for the Accounts of Sheriffs, and other Officers in the Exchequer; which is twice a Year. An. 51 H. III. 5. In another Sense *Profer* also signifies the Officer or Endeavourer to proceed in any Action by any Man concerned so to do.

**PROEMPTOSIS**, [*Astronomy*] is that which causes the New Moon to appear a Day later by means of the Lunar Equation, than it would do without that Equation.

**PROFILE**, [in *Architecture*] the Figure or Draught of a Building, in which the several Heights, Widths and Thickneses are expressed as they would appear, if the Building were cut down perpendicularly from the Roof to the Foundation, and thence a *Profile* is also called a Section, and by *Vitruvius*, *Sciagraphy*; also a Design or Description to a Plan or *Ichnography*; also the Contour or Out-Line of a Building or a Member of Architecture, as a Base, a Cornice, &c.

**PROFILE**, in Fortification, is the Representation of the Height, Depth and Thickness of any Work, and supposes the Work cut perpendicularly down from Top to Bottom; as in the Figure annexed, where you have the Profile of a *Rampart*, *Faussebray*, *Foss*, *Covert-way* and *Esplanade*.



*a b l m* is the Solidity of the Rampart, *a m* its Base; *b l* its Top; *b c* its perpendicular Height; *a b* its inward *Talus* or Slope; *l m* its outward *Talus* or Slope; *b e* is the *Terre-plain*; *e l* is the Base of the *Parapet*, *e d* its *Banquet*; *f h* is the in-

ward *Talus* of the *Parapet*, *i l* the outward one, *b i* its upper one; *b z* is the inward Height of the *Parapet*, *i k* the outward Height; *l* the *Cordon*; *n o p q* represents a *Faussebray* with its *Banquet*, &c. *q r* is its *Lixiere* or *Berm*; *r s t u x* is the



the Foss or Ditch; *rs* the Scarp; *u y* the Counterscarp; *t* the Lunette; *w u* the Depth of the Ditch; *x y* the Covert-way; *x z \** the Parapet and Glacis of the Covert-way; *y z* the Height of the Banquet and Parapet of the Covert-way; *x \** the Basis of the Glacis; *z \** the Slope of the Glacis.

PROFLUVIUM, [in *Physick*] any kind of Flux or liquid Evacuation, as, *Profluvium Ventrīs*, a Flux of the Belly. *F.*

PROFRE *Vicecomitis*. Tho' the certain *Debet* of the Sheriff could not be known before the finishing his Accounts, yet it seems there was anciently an Estimate what this constant Charge of the Annual Revenue amounted to, and what the constant Allowances amounted to according to a *Medium*; and those Summs were paid into the Exchequer at the Return of the Writ of Summons of the Pipe; and they were, and are to this Day called by this Name *Profre Vicecomitis*. But altho' these *Profers* are paid, yet if on conclusion of the Sheriffs Accounts, and after the Allowances and Discharges had by him, it appears that he be in Surplusage, or that he be charged with more than indeed he could receive, he hath his *Profers* paid or allowed to him again.

PROJECTIVE *Dialling*, is the way of Drawing, by a Method of Projection, the true Hour-Lines, Furniture of Dials, &c. on any kind of Surface whatsoever, without any regard had to the Situation of those Surfaces, either as to *Declination*, *Re-* or *Inclination*. This curious and in many Cases most useful manner of Dialling, seems to have been the Invention of our Mr. Sam. Foster, formerly Astronomy Professor in Gresham-College. Something of this was printed in his *Posthumous Miscellanies* 1659, and more added by Mr. Leybourn (in his *Dialling*) from a Manuscript which Mr. Foster left behind him.

In order to perform this manner of *Projective Dialling* after Mr. Foster's way, there is necessary a *Semicircle* divided into two Quadrants, whose Divisions must begin, and be numbred both ways from the middle Point in the Arch, to the Diameter; which Diameter must be made to receive a Ruler into a Groove made in it, so as that the *Semicircle* may slide easily along it, and be fastened by a Scrue any where upon it: It will be convenient to have two or more of these Rulers of different Lengths. You may see the Figure of this Semicircle and Ruler in *Leybourn's Dialling*, p. 198. But there is no difficulty in understanding the use of it at all; and a Quadrant, divided on both sides, may very well supply the Place of the Semicircle.

The General Use of this Instrument is; Upon a Line drawn any where, to project an Altitude or Depression, above or below the Horizon, from a fix'd Point placed at a distance from that Line.

The manner of doing which is very easie; for if you hold the Edge of the Ruler to the fix'd Point, and also apply the Point of the Edge of the Ruler to the Line given, removing it higher or lower (as occasion requires) till the Thread and Plummet of the Semicircle or Quadrant fall on the Degree of Altitude or Depression intended; for then the Ruler lies at the Altitude or Depth, and so projects it from the fix'd Point into a Line, as was designed.

Two General and Easie ways to project Hour-Line, on all Surfaces, Concave, Convex, &c. Inclinations Reclining or Declining.

1. Let a Gnomon, being first sharpened into a Point, be shaped and fastned in such wise, that it no way hinder either the Draught of the Horizontal Line, or the Point of the Shadow from having free access to the Dial at all times of the Year.

2. Draw an Horizontal Line, by help of your Semicircle in a true Level both in regard of it self; and also to the Point of the Gnomon, through the whole Superficies on which the Dial is to be described. Or having two Points in the same Level, with the Point of the Gnomon, project it upon your Superficies, if it be a rugged one. And if the Superficies be more than one, or if any of them be very much inclined towards the Horizon, or else be very rugged, or far remote from the Gnomon, so that it will not at all, or not so well, receive an Horizontal Line upon it, you may either set up some Board, or such like Object, upon which for a time you are to inscribe the Horizontal Line, and by help of which the Hours were to be projected upon the Superficies; Or else (which perhaps will be better) you may extend a Thread in the Air (it matters not which way, nor whether from the Gnomon towards the Sun, or from the Sun; whether stretcht out in one length, or with returns, so long as it lieth justly parallel, in every Point of it, to the Horizon, and in the same Level with the Point of the Gnomon:) which being fixed in this manner, will very well supply the use of the Horizontal Line: or the Horizontal Line may be partly Thread, and partly drawn upon the Superficies, as occasion shall be. And upon it may any Point be transferred, and signed out by slipping knots of Thread tied upon it.

3. Upon the Superficies of the Dial, observe the Point of the Shadow of the Gnomon (making a mark at it) and the Sun's Altitude, both of them at the same Instant of Time.

4. By the Altitude observed, compute the Azimuth of the Sun from the Meridian.

5. The same Azimuth must be transferred unto, or projected upon, the Horizontal Line by help of a Perpendicular Thread, covering to your sight (as it hangeth down) the Points of the Gnomon and Shadow both together; and at the same view cutting through the Horizontal Line: observe then punctually where it cuts through the same Line, for that same Section being signed thereon, shall be the Azimuth projected into the Horizontal Line.

6. Let any kind of Board or Past-board be now applied to the Point of the Gnomon; so, as that it may be staid, either upon the Horizontal Line (where it may so be conveniently) or at least so placed toward the Horizontal Line, that it may have a just respect unto it, and in that posture may have some stay for the edge of it to rest upon, that after it is furnished with such necessary Lines as must be drawn upon it, it may be placed in its former just Posture without any Impeachment. Upon this plain so placed, let the Point of the Gnomon be signed, which may be called the Center; and from this Center to the Sign of the Azimuth, before projected into the Horizontal Line, draw a right Line; this right Line so drawn, shall represent



sent upon the Board or Past-board, the same Azimuth which was before computed.

7. Then taking away the same Plain, draw upon it the Meridian or Line of 12; extending it from the Center before noted, at the true Angle that it hath from the Azimuth before computed and described, and also toward the true Coast of the World. And let it be extended on both sides the Center, if need be.

8. To the Meridian so pitched upon the Past-board, draw (from the Center) the Lines of an Horizontal Dial made to the Latitude wherein you are.

9. Then again, let the plain Board or Past-board be applied to its former situation, the Center of the Horizontal Dial resting upon the Point of the Gnomon, and every thing else answering to the same just Posture that it had at the first. Which done, let a Thread be fixed in the Center of the Horizontal Dial, by help whereof you may transfer every Hour from the Past-board into the Horizontal Line. Let every Hour be therein noted (by fixing marks upon the Horizontal Line where it is drawn, or by slipping Knots upon the Thread, where a Thread Horizontal Line is used) especially mark out the Hour of 12: For which (if it chance to run besides the Superficies) some kind of Object (whereon the Horizontal Line is also to be drawn) or an Horizontal Thread must be fastned, that may receive it, till such time as your Dial be finished.

10. After all this, take your Plain away (for there will now be no more need of it) and conjecture whereabouts the Axis of the World would pass from the Point of the Gnomon to the Poles of the World, for into that place is the Meridian to be projected. Which that it may be done more commodiously, if no object stand in the way that will receive it, you must place one there, it matters not whether above or below the Gnomon, chuse that which is most convenient: Or, a Thread laid aslope in the Meridian justly as it ought, will serve as well as may be. If then you hold up a perpendicular Thread, so that by your Eye you may see the Point of the Gnomon, and also the Point of 12 in the Horizontal Line, both together, the same Thread so hanging, shall shew where the Meridian is to be drawn. Or, you may extend a Thread from the Point of the Gnomon to the Point of 12 in the Horizontal Line, which Thread shall represent the Line of 12: And staying your Thread there, close to it, hang up two perpendicular Threads at a good Distance, so shall the same two Threads, give you the track of the Meridian Line.

11. The next Work will be to project one of the Poles of the World (that namely, which lies the same way that this projected Meridian doth from the Point of the Gnomon) into this Meridian. And this is done by elevating or depressing your Semicircle, from the Point of the Gnomon towards the Meridian Line, according to the Latitude of your Place; for so will the Ruler of the Semicircle, or a Thread extended along by it, sign out the very Pole Point. If now you extend a Thread from this Pole Point, to the Point of the Gnomon, the same shall represent the Axis of the World.

12. Last of all; by these helps, all the Hours may easily be projected. For if the Eye do lay, or project, this Thread or Axis upon each Point of

those Hours that were inserted before into the Horizontal Line, the Axis upon an Hour Point, or a Point upon the Axis, each one of those Projections shall represent upon your Dial, each of the Hours required, and will shew upon every Object that stands in the way, where the Hours are to be drawn. Or, where convenient room is wanting to place the Eye, so as it may make this Projection; there may two Threads be used for the same purpose, one whereof must be fastned to the Point of the Gnomon, the other to the Pole designed in the Meridian Line. Then stretching one of the Threads to any of the Points noted in the Horizontal Line, and holding it there, you may take the other, and extend it to the Superficies, so as it may closely pass by the first Thread, by which Work you may make as many Points upon your Superficies as you please, thro' which each Hour is to be drawn. Having thus traced the way before hand, you may afterward draw the Hour without any difficulty, be the Superficies never so irregular. Among which Lines, the Shadow of the Point of the Gnomon, as it creepeth along, will shew the Time of the Day.

If a Point be assigned upon any Superficies Flat or Curved, one, or more, wherein the Hour-Lines and Axis shall concur, how to project the Hours to that Point, and to set up an Axis after the ordinary manner to give Shadow to them without any knowledge how the Dial standeth, in respect either of the Declination or Inclination.

1. To the Point assigned (upon any side of it) by direction of your Semicircle or other Level, stretch out an Horizontal Thread, serving for the Horizontal Line; this Horizontal Line need not be one direct Line, but may be turned at one or more Angles, provided that it lie totally in the Superficies of the Horizon.

2. With a perpendicular Thread held up, project the Sun into the assigned Point, and into the Horizontal Thread, and tie a little mark of Thread upon the same Horizontal, through which the Shadow cutteth. At the same instant also, take the Sun's Altitude.

3. By the Altitude taken, find out the Azimuth; this Azimuth, what-ever it be, is represented by the knot.

4. Apply a Past-board to the assigned Point, and hold it flat that it may answer to the Horizontal Thread also, and upon this Past-board, protract your Azimuth by a Thread extended from the Point assigned for the Center, to the mark upon the Horizontal Thread. This done,

5. By help of that Azimuth upon your Past-board, protract the Meridian Line, observing the true Coast, and quantity of the Angle from the Azimuth: and to the Meridian describe an Horizontal Dial.

6. Applying the Past-board to its place again, all things standing right as before, project all the Hours in the Horizontal Thread from off the Past-board, and set marks upon the same for the Points of each several Hour, which marks may be little moveable Knots to slip to and fro upon the same Thread.

7. Project the Meridian Point by a perpendicular Thread upon some object into that place whereabouts you imagine the Axis of the World would pass, above or below from the Point assigned for the Center.



8. With your Semicircle elevated or depressed (as it shall be required) from the Point assigned for the Center, according to your Latitude project the Pole of the World.

9. Extend a Thread from the Point assigned for the Center to the Poles of the World, which shall represent the Axis.

10. By the Point upon the Horizontal Thread, and this Axis (either by your Eye, laying the Axis to the Hour-points, or laying the Hour-Knots to the Axis) you may project all the Hours and draw them: Or else you may let the Axis alone, and content your self with the Pole point projected into the Meridian; for if from the Point assigned to be the Center or meeting of the Hours and Axis, you extend a Thread to each Hours-point in the Horizontal Line, and do repose (with your Eye) the same Thread upon the Pole-point, then shall the Shadow of the Thread give you that Hour-line, and do so in all the rest.

11. Your Thread or Axis lying in its true situation, you may easily fit an Axis to the same posture. If your Dial be described upon a plain Superficies, you may then (by one side of a Nominal Square, applied to a Thread or Axis, and the other side lying upon the Plain) find out the substyle, and measure from it the Elevation of the Axis above the Plain: But if the Dial be described upon a curved Superficies, you must be content to set up your Axis by the direction of the Thread only.

12. This Point assigned for the Center, being a Point of the Axis, is as it were the Apex of the Gnomon, unto which all the Work is projected. But if it be required to set up an Axis to such a Superficies, upon which the Axis and Hours will not meet in any tolerable manner, because perhaps the Axis may be but of very small Elevation above the Superficies, and yet an Axis is required; in this Case, set up any Point (of Wire, or such like) of such distance from the Superficies, as that the Axis and Hours may be distinct: And through that Point let it be required to make the Axis pass, you have no more to do but only to project to this Point, as before, by letting the Shadow of a perpendicular Thread pass through that Point, and noting the same upon your Horizontal Thread, and counting that end of the Wire as your Center, proceed as before; for the Thread that lies to project the Hours is a pattern for the Axis.

This way is as general as the former, serving to project the Hours upon many Superficies, be they plain or curved, and however situate whether contiguous, or separate, and that without any laborious Inquisition of any of their Situations, in respect of Inclination or Declination. If you will put in that Furniture which is usual, you must make some Mark (Notch, or Button) upon your Axis, unto which (as representing the Center of the World) by help of your Semicircle you are to project the Altitudes of such great or lesser Circles as you intend to insert; as hereafter shall be taught.

The 12 Propositions in the first way were to project to an Apex.

These 12 Propositions answerable in the second way are to project to an Axis.

And after this Method it will be easie, and often very useful and curious, to Project a Dial from a small Hole made in a Pane or Quarry of Glass; (the rest of the Glass being covered) or which is

better, a Plate of Tin with a round Hole of  $\frac{1}{8}$  of an Inch in Diameter, being put in the room of a Pane of Glass for the Sun shining thro' that Hole, will cast a bright Spot of Light into the Room. Suppose then such a Hole to be the *Nodus*, or Point of the Top of the Perpendicular Style of any Dial, you may draw one or more Dials, (each side or part of the Room being a different Plane) after this manner.

(1.) Apply an Horizontal Dial in a true Horizontal Position, so that its Centre lie in that of the Hole in the Pane; and then by a Thread fixed at one end of the Centre of the Dial, and laid over successively, every Hour, Half-Hour, Quarter, &c. find corresponding Points in the Sides of the Room where those Hour Lines intersect them: Then (2.) The Twelve a-Clock Line being an Azimuth also as well as an Hour-Line, you may by a String and Plummets brought just to touch that Thread when strained over the 12 a-Clock Hour-Line, transfer that *Meridian Line* up to the Ceiling or down to the Floor, as you shall find occasion. (3.) Next in this *Meridian Line* find another Point, (by help of a Thread elevation to a proper Height (in Degrees) by means of a Quadrant) from which, a Line or Thread extended to the Hole in the Window may represent either the *Direct* (or *Reversed*) Axis of the Earth; and therefore if you fix a Thread in one or both of these Points (or rather Poles) and extend it or move it along by the side of the other Thread, as it is brought successively over every Hour Line on the Horizontal Dial (in whose Centre, as well as in that of the Hole it is fixed) and as it is extended to the corresponding Hour-Points before found in the Room: I say, that moveable String shall any where on the Ceiling or on the Floor, trace out any Hour-Line which the Horizontal Thread shall successively represent.

And this Method of Projective Dialling, will direct us into this excellent Mechanick way of *Dialling* or drawing *Hour Lines* on any Plane how irregular soever as to Surface or Situation. Under the Plane where you intend to make a Dial, draw a true Level or *Horizontal Line*, and then to set it horizontally, a Scaffold or Frame of Boards, greater or lesser, according to the designed Bigness of the Dial. Next, by some good Dial, Clock, Equinoctial Ring, &c. get exactly the true Hour of the Day, and set your Minute Watch to it. Then place a good Horizontal Dial for the Latitude of the Place and which hath a fine String fastened in its Centre, on your Level Plane or Scaffold, and the Sun shining, turn it about till it shew the true Hour of the Day there. Then fix it; and by the Motion of your Thread over every Hour, Half, Quarter, &c. you may easily project them all into your Plane or Place designed for the Dial.

**PROFIL** (*French*) a Term in Painting, signifying properly a Face or Head set sideways, as usually on Medals, and such a Face is said to be in *Profil*, or in a Side View. 'Tis also spoken of the View of a Building, or City, &c. in Opposition to the Plan or Ground-plot of it; and so appears to have much the same sense as a Prospect of any Place, City, or Piece of Architecture, viewed sideways, and expressed according to the Rules of *Perspective*. This is called the *Profil* of such a Place.



Place, City, &c. Some call the Out-lines of any Figure its *Profil*, but that way of speaking is improper.

PROFUNDUS, a Muscle, which bends the Fingers.

PROGNOSIS & *Signa Prognostica*, are Signs whereby we know what will become of the Patient, as to Recovery or Death.

PROGRESSION *Arithmetical*, or continual *Proportion Arithmetical*, is when Numbers (or other Quantities) do proceed by equal differences (either increasing or decreasing.) As,

2, 4, 6, 8, 10, 12, 14, &c.  
3, 5, 7, 9, 11, 13, 15, &c.  
16, 14, 12, 10, 8, 6, 4, &c.

In the two former, is a continual Increase, in the latter a continual Decrease, by two in all of them; which is called the *Common Difference*, or *Common Excess*.

1. If three Quantities are in *Arithmetical Proportion Continued*, the Sum of the *Extreams* is equal to the Double of the *Mean*.

Let  $a$  be the first Term, and  $x$  the Common Difference; then will the three Quantities be  $a, a+x, a+2x$ ; or  $a, a-x, a-2x$ , if the Progression descend.

Now  $a+x$ , doubled, is  $= a+a+2x = 2a+2x$ . Q. E. D.

2. If four Quantities are so, the Sum of the *Extreams* is equal to the Sum of the *Means*.

Let the four Terms be  $a, a+x, a+2x, a+3x$ .

'Tis plain, that the Sum of the *Means*, and of the *Extreams*, is  $2a+3x$ .

3. If never so many Quantities are so proportional, the Sum of the *Extreams* is always equal to the Double of the *Mean*, if the Number of the Terms be odd, or to the Sum of any two Terms equally distant from the *Extreams*.

Thus in the following Series,

2. 4 6 8 10 12 14  
 $a, a+x, a+2x, a+3x, a+4x, a+5x, a+6x$   
16 18 20 22  
 $a+7x, a+8x, a+9x, a+10x$ .

The Sum of the *Extreams*  $2a+10x$  is equal to  $a+5x$  multiplied by 2; that is, the Double of the middle Term: As it is also to the Sum of any Two of them equally distant from both *Extreams*.

And this must ever be, because the last Term contains in it the first, and also the common Difference super-added as often as the Number of its Place is distant from the first Term: But the first Term hath no Addition of the Difference at all; and as the second Term hath one Difference or Ratio more than the first, the third one more than the second, &c. so the last save one, hath one less than the last of all; the last save two, one less than the last save one, &c. So that the Sum of any two of these equally distant from the *Extreams*, must be equal to the Sum of the

*Extremes*; because one encreases as much as the other decreases.

Hence 'tis plain,

### C O R O L L A R I E S.

1. That the Sum of any Number of Terms in such a Progression may be had, if the Sum of the *Extremes* be multiplied by half the Number of the Terms, or half that Sum by the whole Number of the Terms.

2. To gain the Sum of never so many Quantities in this *Progression*, there is nothing necessary to be given but the *Extremes* and the Number of Terms: So that if by having the *First Term* and *Common Excess*, one could get the *Last*, 'twould strangely dispatch Questions in *Progression*.

3. Which last Term in such a *Progression* may be had easily, by multiplying the Number of the Terms, lessened by one, into the Common Excess, and then to that Product adding the first Term.

Thus, if the last Term, in a *Progression* of 52 Places were desired, where the Common Difference is 3, and the first Term 5:

Multiply 51 by 3, it produces 153; to which adding 5 the first Term, you have 158 equal to the last Term in such a *Progression*.

4. Wherefore if the *Progression* begin with a Cypher, (which is the most Natural and Simple *Progression*; for when it begins with any other Term, 'tis in reality a Compound of two *Progressions*; one of Equals, as of  $a, a, a, a$ , &c. and the other of *Arithmetical Proportionals*, as  $0, x, 2x, 3x, 4x$ , &c.) then I say, the Sum of all the Terms will be equal to half the Product of the last Term multiplied by the whole Number of the Terms: For by the First Corollary, the Sum of all the Terms will be equal to the Sum of the *Extremes* multiplied by half the Number of Terms.

Thus, suppose

0. 2. 4. 6. 8. 10. 12. 14. 16. 18. 20.

Or,

0.  $x, 2x, 3x, 4x, 5x, 6x, 7x, 8x, 9x, 10x$ .

20 the last Term, multiplied by 11 the Number of the Terms, gives 220; the half of which, 110, is the Sum of all the Terms.

For, by *Corollary* the First, 20, the Sum of the *Extremes*, multiplied by 5.5 half the Number of Terms, produces 110, the Sum of all the Terms.

5. Hence this very useful Theorem may be deduced, that the Sum of all the Terms in any such *Progression*, beginning from 0, is *Subduple* of the Sum of so many Terms, all equal to the greatest. For let the first Term be 0, and the last  $x$ , and the given Number of the Terms  $n$ ; then (by N<sup>o</sup> 1.) will the Sum of all the Terms of the *Progression* be  $\frac{1}{2}nx$ , which is half or *subduple* of  $nx$  equal to the Number of so many Terms equal to the greatest. Q. E. D.

6. The



6. The Sum of a Simple Arithmetical Progression, (*i. e.* ascending by the Cardinal Numbers) continued from Unity *ad Infinitum*, is subduple the Sum of the same Number of Terms, each of which is equal to the greatest; or, on the contrary, this latter Sum is double of the former. By prefixing a Cypher before unity, this would be but the Case of the last Corollary, the Sum of the *Progression* remaining still the same.

But that this is true in an infinite Series beginning from Unity, (for in a Finite or Determinate one, the Proportion of the Sum is always less than double; tho' it always approaches to it, and comes so much the nearer by how much greater the Series is) we shall now thus demonstrate:

To the Sum of Three Terms, 1, 2, 3, *i. e.* 6, the Sum of as many equal in Number to the greatest, *i. e.* 9, has the same Proportion as 3 to 2; but to the Sum of Six Terms, 1, 2, 3, 4, 5, 6, *i. e.* 21, the Sum of as many equal to the greatest, *i. e.* 36, has the same Proportion as 3 to  $1 + \frac{3}{4}$  that is, 3 to  $2 - \frac{1}{4}$ , the Decrease being  $\frac{1}{4}$ ; but to the Sum of Twelve Terms, which may be found by *Coroll.* 1. equal 78, the Sum of so many equal to the greatest, *viz.* 144, has the same Proportion, (dividing both sides by 48) as 3 to  $1 + \frac{3}{8}$ , *i. e.* 3 to  $1 + \frac{1}{2} + \frac{1}{8}$ , (for 24 make  $\frac{1}{2}$ , and the Remainder  $\frac{6}{24}$  is the same as  $\frac{1}{8}$ ) that is, as 3 to  $2 - \frac{1}{4} - \frac{1}{8}$ , the Decrement being now  $\frac{1}{8}$ . Since therefore, by doubling the Number of Terms onwards, you'll find the Decrement to be  $\frac{1}{16}$ , and so onwards in double Proportion; the Sum of an infinite Number of such Terms, in Arithmetical Progression, equal to the greatest, will be to the Sum of the *Progression*, from 1 *ad infinitum*; as 3 to  $2 - \frac{1}{4} - \frac{1}{8} - \frac{1}{16}$ , &c. that is, by *Coroll.* 1. and 2, as 3 to  $2 - \frac{1}{2}$ , that is, as 3 to  $1 + \frac{1}{2}$ , or as 2 to 1. *Q. E. D.*

7. The Sum of any Duplicate Arithmetical Progression, continued from Unity *ad infinitum*, is subtriple of the Sum of as many Terms equal to the greatest, as is the Number of Terms: For any such Finite Progression is greater than the Subtriple Proportion, but approaches nearer and nearer to it continually, by how much the farther the Series of the Progression is carried on. Thus the Sum of Three Terms, 1, 4, 9, = 14, is to thrice 9 = 27, as  $1 + \frac{1}{3}$  or  $1 + \frac{2}{3}$ , or  $1 + \frac{1}{2} + \frac{1}{6}$  to 3, (dividing both sides by 9) the Sum of Six Terms, 1, 4, 9, 16, 25, 36, &c. *viz.* 91 to Six times 36, *i. e.* to 216, (dividing both sides by 72) is as  $1 + \frac{1}{4} + \frac{1}{8}$  to 3: and the Sum of Twelve Terms 650, to 12 times 144, *i. e.* 1728, (dividing both sides by 576) is as  $1 + \frac{1}{8} + \frac{1}{16} + \frac{1}{32}$  to 3, &c. the Fraction adhering to them thus constantly decreasing, some by their Half parts, others by Three quarters: (for  $\frac{1}{8}$  is  $\frac{1}{2} \times \frac{1}{4}$ ; therefore the first Decrement is  $\frac{1}{2} \times \frac{1}{4}$ ; and  $\frac{1}{16}$  is  $\frac{1}{4} \times \frac{1}{4}$ ; there the second Decrement is  $\frac{1}{4} \times \frac{1}{4}$ , &c.) Wherefore the Sum of the Infinite Progression will be to the Sum of the like Number of Terms equal to the greatest; as,

$$\begin{array}{r} 1 + \frac{1}{2} + \frac{1}{4} \\ - \frac{1}{4} - \frac{1}{8} \\ - \frac{1}{8} - \frac{1}{16} \\ - \frac{1}{16} - \frac{1}{32} \end{array}$$

*Coroll.* 2d and 4th, in *Progression Geometrical*.

But the Sum of a Triplicate Arithmetical Progression, (*i. e.* ascending by the Cubes of the Cardinal Numbers) proceeding from 1 thro' 27, 64, &c. *ad infinitum*, is subquadruple of the like Number of Terms equal to the greatest: For the Sum of Four Terms, 1, 8, 27, 64, *i. e.* 100, to 4 times 64, *i. e.* 256, (dividing both sides by 64) will be found to be as  $1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8}$  to 4; but the Sum of 8 Terms, 1, 8, 27, 64, 125, 216, 343, 512, *i. e.* 1296 to 8 times 512, *i. e.* 4096, (dividing both sides by 1024) will be found to be as  $1 + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \frac{1}{32}$  to 4, &c. The adhering Fractions thus constantly decreasing, the one by their Half part, the others by Three quarters, (for  $\frac{1}{4}$  is  $\frac{1}{2} \times \frac{1}{2}$  and  $\frac{1}{8}$  is  $\frac{1}{4} \times \frac{1}{2}$ , &c.) Wherefore the Sum of the Infinite Progression will be to the Sum of a like (Infinite) Number of Terms, equal to the greatest; as,

$$\begin{array}{r} 1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} \\ - \frac{1}{4} - \frac{1}{8} - \frac{1}{16} \\ - \frac{1}{8} - \frac{1}{16} - \frac{1}{32} \end{array}$$

*Coroll.* 2d and 4th, as 1 to 4. *Q. E. D.*

PROGRESSION *Geometrical*, or *Geometrical Proportion Continued*, is when Numbers, or other Quantities, proceed by equal Proportion or *Ratios*, (properly so called) that is, according to one Common Multiplier, or *Exponent* of the Common *Ratio*, whether Increasing or Decreasing. As,

$$2. 4. 8. 16. 32. 64. \&c. ::$$

Or in Species; supposing *a* the First Term, and *r* the *Ratio*, here equal to 2.

$$a. ra. rra. rrra. rrrra. rrrrra. \&c. ::$$

For, every Term (but the first) arises from the multiplication of the *Ratio*, or some Power of it, into it.

The following Numbers are Continual Proportionals decreasing, according to the Common *Ratio*, 2 or *r*.

$$128. 64. 32. 16. 8. 4. 2. \&c. ::$$

$$ar^5. ar^4. ar^3. ar^2. ar. a. \&c.$$

And as in the former Rank of Numbers 2 was the Common Multiplier, in this 2 is the Common Divisor; or, which is in effect the same, the Common Multiplier is  $\frac{1}{2}$ .

The most Natural and Simple Geometrical Progression, is when it begins with Unity; as,

$$\begin{array}{cccccc} 2 & 4 & 8 & 16 & 32 \\ 1. & r. & rr. & rrr. & rrrr. & rrrrr. \&c. \end{array}$$

When it begins with any other Term, as *a* in the former Progression, it is in effect but such a Progression as this latter, multiplied into that first Term all along.

## PROPOSITION I

If there are Three Quantities continually Proportional, the Rectangle of the Extremes is equal to the Square of the Mean Term. As,



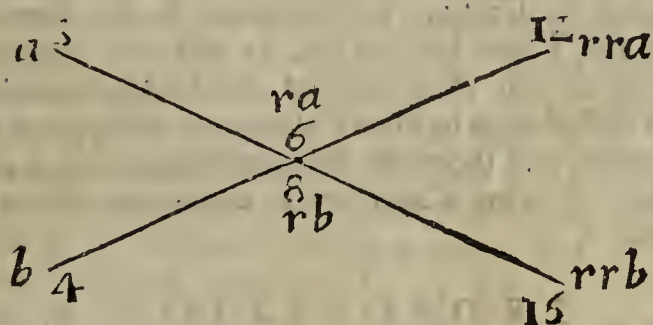
As, suppose

$$a, ra, rra, :: \text{Or, } 3. 6. 12. ::$$

Its plain that the Extremes  $a, rra$ , multiplied into one another, are equal to the Mean  $ra$  multiplied into it self, or in Numbers, that 3 times 12 is equal to 6 times 6.

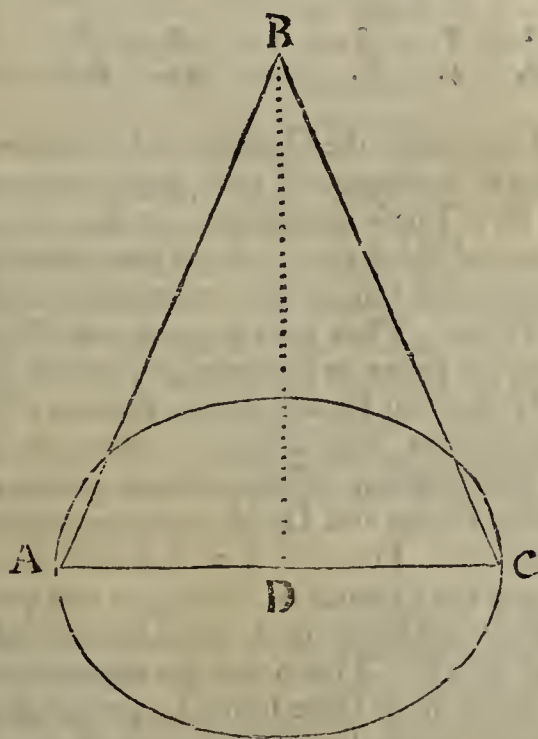
### SCHOLIUM.

Also, If Three Quantities on each side are in the same Continual Proportion, as

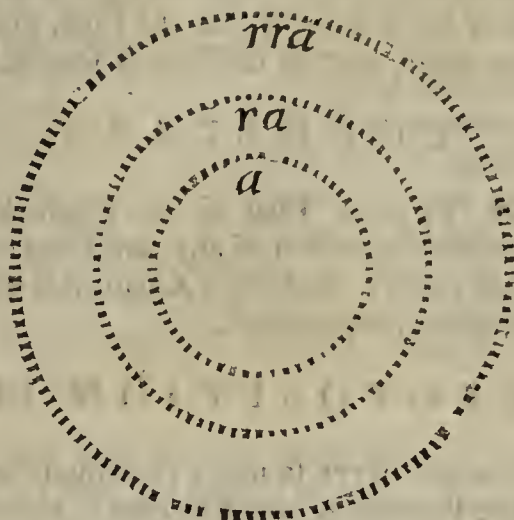


the Rectangles of the Extremes made cross-ways are equal to the Rectangle of the Mean Term, being every way  $rrab$ , or 48.

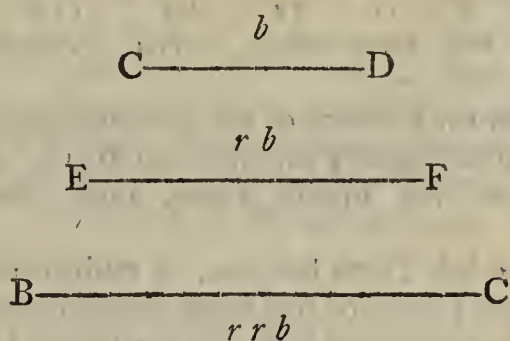
And from hence, *Sturmius*, in his *Mathesis Enucleata*, Prop. 17. of Book 1. *Schol.* very briefly demonstrates that Proposition of *Archimedes*, that the Surface of a Right Cone is equal to a Circle whose Radius is a Mean Proportion between the Side of that Cone and the Semidiameter of its Base.



Let  $EF$  (or  $rb$ ) be a Mean Proportional between the Side of the Cone  $BC$ , (or  $rrb$ ;) and the Radius of the Base  $CD$ , (or  $b$ ;) and let there be an equal Number of Peripheries,  $rra$ ,  $ra$ , and  $a$ , answering to an equal Number of Ra-



di in the same proportion; then will half the first Radius,  $BC$ , (or  $rrb$ ) multiplied into the Periphery  $a$ , (that is  $\frac{1}{2} rra b$ ) be equal to half the Product of the middle Line into the middle Peri-



phery, that is (as before) half  $rrab$ : The former of which is equal to the Surface of the Given Cone, by the 4th *Conf.* of his *Def.* 18. and the latter to the Area of the Circle, whose Radius is the Mean Proportion  $EF$ , (by the 2d *Conf.* of his *Def.* 15.) *Q. E. D.*

And from hence also flows naturally this other Proposition, That the Surface of the Cone, half  $rrab$ , is to its Base half  $ab$ ; as the Side of the Cone  $rrb$ , is to the Radius of the Base  $b$ . For

$$\frac{1}{2} rra b : \frac{1}{2} a b :: rrb : b.$$

### PROPOSITION II.

If four Quantities are proportional, either continually or discretely, the Product of the Extremes is equal to the Product of the Means.

For if  $a, ra, rra, rrra, ::$ , or  $2. 4. 8. 16. ::$  'tis plain the Product of the Extremes and of the Means, is the same Quantity  $rrraa$  or 32.

In discrete Proportionals, let  $a : ra :: b : rb$ ; that is,  $2 : 4 :: 15 : 30$ . The Product of the Extremes and of the Means can here be no other than  $rab = 60$ .

On which Proportion is grounded the *Golden Rule*, or *Rule of Three* in Arithmetick; so called, because having Three Numbers, (as  $2. 4. 15$ .) it teaches how to find an unknown Fourth Proportional: For altho' this Fourth be unknown, yet its Product by 2 the First Term is known, because 'tis the same with the Product of the Means 4 and 15.



Wherefore the Rule directs us to multiply the Third by the Second, that you may thereby obtain the Product of the *Extremes*; which divided by one of the *Extremes*, viz. the First, must needs give the other, that is, the Fourth sought.

C O R O L L A R Y.

Hence 'tis plain, That if two Products arising from the Multiplication of any two Pairs of Quantities, are equal; those four Quantities will be at last discretely proportional.

P R O P O S I T I O N III.

If there are never so many continual Proportionals, the Product of the *Extremes* is equal to the Product of any two of the Means that are equally distant from the *Extremes*, as also to the Square of the Mean or Middle Term, if the Number of the Terms be odd.

Thus in this Progression,

2 4 8 16 32 64 128.  
a. ra. rra. rrra. rrrra. rrrrra. rrrrrra. &c.

It's plain the Product of the Extremes, and of any two Terms equally distant from them, and the Square of the middle Term, must always be  $r^6aa$ .

As the last Term but one, is multiplied into a Degree or Power of the Ratio less by one than the last; so the second Term is multiplied into one more than the first: And therefore the Rectangle of the Extremes must still be the same Quantity with that of the Product of any two Terms equally distant from that; and this also equal to the Square of the Middle Term, if the Number of them be odd.

P R O P O S I T I O N IV.

Having the first and last Terms, and the Ratio. To find the Sum of all the Terms in any Geometrical Progression, Mr. Oughtred gives this Method.

Let  $a$  be the first Term, and  $y$  the last; then let  $z - y =$  all the *Antecedents*, and  $z - a =$  all the *Consequents*. Therefore, by Composition of Proportion, it plainly follows, That  $a.ra :: z - y. z - a$ . That is, the first Term is to the second :: as the Sum of all the Antecedents is to the Sum of all the Consequents: Wherefore by Multiplication of the Extremes and Means,  $za - a = r a z - r a y$ . Wherefore transfer  $za$ , and it will be  $-a a = r a z - r a y - z a$ . Transpose  $r a y$ , then will  $r a y - a a = r a z - z a$ . Divide each Part by  $r a - a$ , and  $z$  will be equal to  $\frac{r a y - a a}{r a - a}$ . That is, Multiply the second and last Terms together, and from the Product subtract the Square of the first Term; and then divide the Remainder by the Difference between the first and second Term, and the Quotient will be the Sum of all the Terms.

Example, in this Series 2. 4. 8. 16. 32. 64. 128.

$$\begin{array}{r} 2 \\ 4 \\ 8 \\ 16 \\ 32 \\ 64 \\ 128 \\ \hline 2) 508 \quad (254 = 254 \end{array}$$

The  $z$  of all the Terms but the last, may be found very easily thus: From the last take the first, and divide the Remainder by the Ratio lessened by Unity; the Quotient is the Sum of all the Terms but the last, as will very easily appear if you multiply and divide Algebraically: Which Rule is in some Cases more ready than the former, and therefore 'tis sometimes referred to in the following *Confectaries*, under the Name of Rule 2.

P R O P O S I T I O N V.

Having the Ratio of the Terms in any Geometrical Progression, To find any of the other Terms, or to find any Term sought.

As for Instance: In Progression, whose Ratio is 2, to find the 24th Term; or to answer expeditiously the common Question of the Price of an Horse sold at a Farthing a Nail (of his Shoes) and doubled every time.

Begin and double, as 'tis easie to do, for 6 or 8 times, thus,

0 1 2 3 4 5 6 7 8  
1. 2. 4. 8. 16. 32. 64. 128. 256.

And then over the Geometrical Numbers place a Series of Arithmetical ones, beginning with 0, as you see: These are Indexes or Exponents of the other, and shew every where how often the Ratio is multiplied into it self, to produce any particular Term. Thus over 64, the 7th Term, there stands the Index or Exponent 6; which shews that 64 is the 6th Power of the Ratio 2, (since the Series begins with Unity.) Now the Addition and Subtraction of the Indexes answers to the Multiplication and Division of the Numbers they stand over: For  $3 + 5 = 8$ , which is the Index of 256, the Product of 8 into 32; and  $7 - 4 = 3$ , which is the Index of 8, the Quotient of 128 divided by 16. This being the admirable Property and vast Use of these Indices, (which is the Reason and Foundation of the whole Business of the *Logarithms*, as you may see under that Word) 'tis very easie by their help to come at any Term, tho' never so remote either way. For supposing I would have the 16th Place in this Progression, since  $8 + 8 = 16$ , I find, that if I multiply 256 by it self, or square it, it will give me 65536, which is the 16th place; and since  $16 + 7 = 23$ , if I multiply that Number by 128, it will produce 8388608, which is the 24th Place or Nail; (for the Indices begin with 0) and therefore that doubled, according to the Condition of the Question, will give 16777216 Farthings, which reduced, is 17476 l. 5 s. 4 d.



From which *Propositions* about *Geometrical Proportionals*, these wonderful *Corollaries* may be deduced.

1. That 'tis possible by these Rules to collect an *Infinite Series* of Proportional Terms into one Sum, altho' it is impossible to run over all the Terms separately, because Infinite. Thus, in a continu'd Series of Fractions decreasing in a double Proportion,  $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}, \&c.$  *ad infinitum*, if you take them backwards, you may justly reckon a Cypher, or 0, for the first Term; (for between  $\frac{1}{2}$  and 0, there may be an Infinite Number of such Terms) and the Infinite Sum of these Terms will be precisely equal to Unity: For subtracting the first 0 from the last  $\frac{1}{2}$ , and the Remainder  $\frac{1}{2}$  being divided by the Name of the Reason lessen'd by 1, that is, by 1, which divides nothing; the Quotient  $\frac{1}{2}$  is the Sum of all the Terms, excepting the last, (by *Rule 2.*) and so the last  $\frac{1}{2}$  being added, the Sum of all in that Series will be 1. Now if the last is not  $\frac{1}{2}$ , but 1, the Sum of all will necessarily be 2; and if 2 be the last, the Sum of all will be 4: In a Word, it will be always double the last Term.

2. And since in this Case the Sum of all the precedent Terms is equal to the last Term, the one being subtracted from the other, there will remain nothing, *i. e.*  $\frac{1}{2} - \frac{1}{4} - \frac{1}{8} - \frac{1}{16} - \frac{1}{32}, \&c.$  *in Infinitum*, is = 0; and also,  $1 - \frac{1}{2} - \frac{1}{4}, \&c.$  or  $2 - 1 - \frac{1}{2} - \frac{1}{4} - \frac{1}{8}, \&c.$  = 0.

3. In like manner the Sum of Infinite Fractions decreasing in tripple Reason in an Infinite Series, ( $\frac{1}{3} + \frac{1}{9} + \frac{1}{27} + \frac{1}{81}, \&c.$  will be equal to  $\frac{1}{2}$ : For if from the last  $\frac{1}{3}$  (again in an inverted Order) you subtract the first 0, and the Remainder  $\frac{1}{3}$  be divided by the Name of the Reason lessen'd by Unity, that is, by 2, the Quotient  $\frac{1}{6}$  will be the Sum of all the Antecedent Terms; and adding to this last  $\frac{1}{3}$  or  $\frac{2}{6}$ , the Sum of all will be  $\frac{3}{6}$  or  $\frac{1}{2}$ .

But had the Fractions decreas'd from  $\frac{1}{4}$  in a Quadruple, or from  $\frac{1}{5}$  in a Quintuple Proportion,  $\&c.$  the Sum of the whole Series would have been accordingly  $\frac{1}{3}$  or  $\frac{1}{4}$ , and so any Series of this kind is equal to a Fraction, whose Denominator is less by an Unite than the Denominator of the last Fraction in that Series, (supposing the Series to be numbred backward, as before.)

4. Generally also, any Infinite Series of Fractions decreasing according to the Proportion of the Denominator of the last Term, and having a common Numerator less by an Unite than the Denominator of the last Term, (as  $\frac{2}{3} + \frac{2}{9} + \frac{2}{27}, \&c.$  or  $\frac{3}{4} + \frac{3}{16} + \frac{3}{64}, \&c.$  or  $\frac{4}{5} + \frac{4}{25} + \frac{4}{125}, \&c.$  is equal to Unity, after the same way as the Series, *Coroll. 1.* which may be comprehended under this kind, and which may be demonstrated in all its particular Cases by the same Method we have hitherto made use of, or also barely subsumed from *Coroll. 3.* For since  $\frac{1}{3} + \frac{1}{9} + \frac{1}{27}, \&c.$  is equal to  $\frac{1}{2}$ ;  $\frac{2}{3} + \frac{2}{9} + \frac{2}{27}, \&c.$  will be equal to  $\frac{2}{2}$  or 1; and so in the rest.

And particularly the Sum  $\frac{3}{27} + \frac{3}{288} + \frac{3}{1152}, \&c.$  decreasing in a Quadruple Proportion, is equal to  $\frac{1}{8}$ ; and the Sum of  $\frac{3}{64} + \frac{3}{256} + \frac{3}{1024}, \&c.$  is equal to  $\frac{1}{16}$ ; and the Sum of  $\frac{7}{64} + \frac{7}{512} + \frac{7}{4096}, \&c.$  decreasing in an Octuple Proportion, is equal

to  $\frac{7}{8}$ : For subtracting the first Term 0, and dividing the Remainder by the Name of the Ratio lessen'd by Unity, that is, by 3, the Quotient  $\frac{1}{3}$ , gives the Sum of all, except the last.

This therefore (*viz.*  $\frac{1}{3}$ ) being added, the Sum of all will be  $\frac{4}{3}$  or  $1\frac{1}{3}$ : In like manner  $\frac{7}{64}$  being divided by the Name of the Reason lessen'd by Unity, the Quotient will be  $\frac{7}{64}$ ; and adding the last, the Sum of all will be  $\frac{8}{8}$ , *i. e.*  $\frac{1}{8}$ : So that hence 'tis evident, that  $\frac{1}{8} - \frac{1}{72} - \frac{1}{288} - \frac{1}{1152}, \&c.$  or  $-\frac{1}{8} + \frac{1}{72} + \frac{1}{288} + \frac{1}{1152}, \&c.$  *in infinitum*, will be equal to nothing; and  $\frac{7}{8} - \frac{7}{64} - \frac{7}{512} - \frac{7}{4096}, \&c.$  = 0.

5. The Sum of an Infinite *Progression*, whose greatest Term is a Square Number, the others decreasing according to the odd Numbers 1, 3, 5, 7,  $\&c.$  is in *Subsequialtern* Proportion of the Sum of the like Number of equal Terms, *i. e.* as 2 to 3. For the Sum of three such Terms, as 9, 8, 5. *i. e.* 22 to thrice 9, *i. e.* 27, (dividing both sides by 9) as 2  $\frac{2}{3}$ , *viz.*  $\frac{2}{3}$  to 3, or 2  $+\frac{1}{2} - \frac{1}{8}$  to 3. But the Sum of Six such Terms, 36, 35, 32, 27, 20, 11, *i. e.* 161, to six times 36, *i. e.* 216 (dividing both sides by 72) is as 2  $+\frac{1}{4} - \frac{1}{72}, \&c.$  the adhering Fractions thus always decreasing, some by half, others by three Quarters, as in *Coroll. 7. Progression Arithmetical*: Wherefore the Sum of the Infinite *Progression* will be to the Sum of the like Number of Terms equal to the greatest, as,

$$2 + \frac{1}{2} - \frac{1}{8} \\ - \frac{1}{4} + \frac{1}{72} \\ - \frac{1}{8} + \frac{1}{288}, \&c. \text{ to } 3; \text{ that is,}$$

by *Coroll. 2d* and 4th, as 2 to 3. *Q. E. D.*

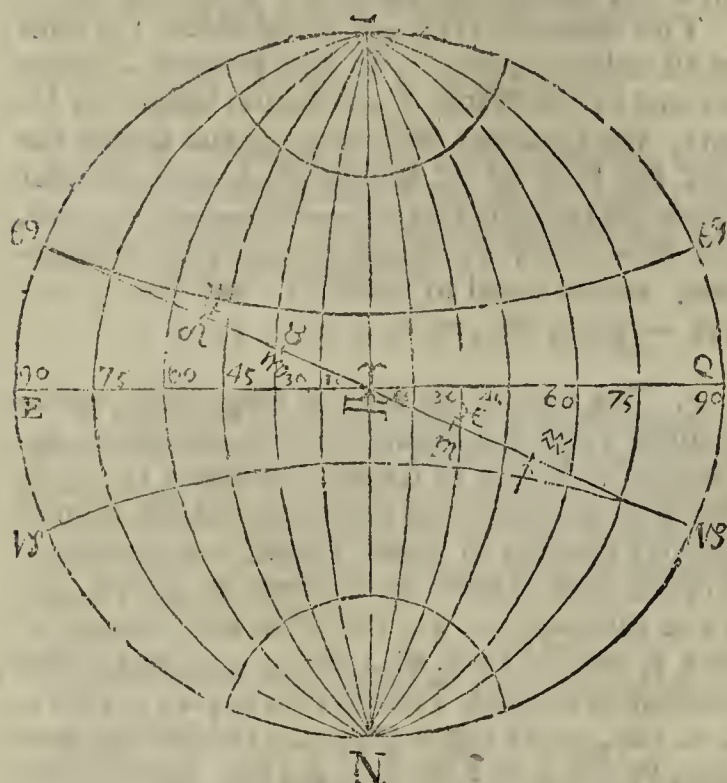
**PROJECTION**, in Chymistry, is putting any Matter to be *calcined* or *fulminated* into the Crucible Spoonful by Spoonful. The pretended Casting of the Powder of the Philosopher's Stone into a Crucible of melted Metal, in order (as they boast they can do) to transmute it into Gold or Silver, is called also *Projection*; and the Matter they cast in, the *Powder of Projection*.

**PROJECTION** of the *Sphere in Plano*, is a true Geometrical Delineation of the Circles of the Sphere, or any assigned Parts of them, upon the Plane of some one Circle; as on the *Horizon*, *Meridian*, *Equator*, *Tropick*,  $\&c.$  And this is either *Stereographick*, which supposes the Eye to be but 90 Degrees distant from, and perpendicular to the Plane of the Projection; or *Orthographick*; when the Eye is at an Infinite Distance.

By what hath been taught in our Doctrine of *Spherical Geometry*, (see that Word) it will be very easy to project the Sphere on any Plane. For the *Analemma*, see that Word. And here follows an Example of the *Stereographick Projection* of the Sphere on the Plane of the *Meridian*, *Equinoctial* and *Horizon*, which gives good Light into the Knowledge of *Spherical Triangles*, the *Doctrine of the Sphere*, *Dialling*,  $\&c.$



The Stereographick Projection on the Plane of the Meridian.



Let Z Q N E be the *Meridian*.

Z and N the *Poles*, as also the *Zenith* and *Nadir*.

E Q the *Equinoctial* and *Horizon*.

Z N the *Equinoctial Colure*, and *Prime Vertical Circle*.

Z 15 N, Z 30 N, Z 45 N, &c. are *Hour-Circles* or *Meridians*, and also *Azimuths*, because the *Pole* is in the *Zenith*.

And to describe these Circles, find the Points 15, 30, 45, 60, &c. in the *Equinoctial*, by setting the Half Tangent of their Distance from  $\Upsilon$ ; and then their Centres are found by setting their Co-secants both ways from their Points of Intersection with the *Equator*.

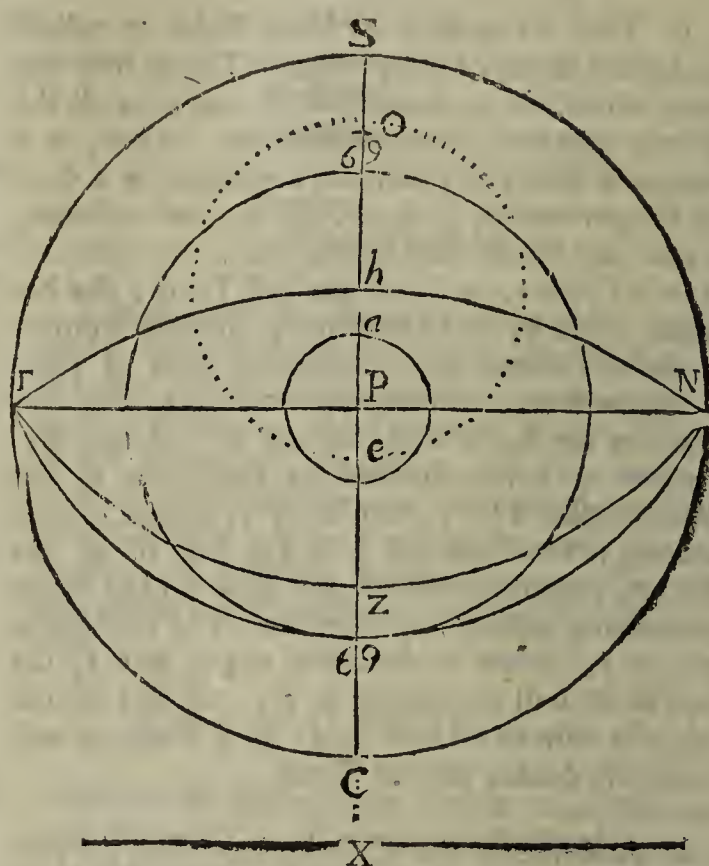
$\odot$ ,  $\ominus$ , and  $\wp$ ,  $\wp$ , are the Northern and Southern *Tropicks*, which are described by setting the Half Tangent of 23 Deg. 30 Min. from  $\Upsilon$  each way: Then the Tangent of its Complement, viz. 66 Deg. 50 Min. each way from thence on the *Colure* produced, gives their Centres. By this Method all *Parallels* of *Declinations* may be drawn.

Or you might have set the Co-secant of the *Parallel* from the Centre of the *Primitive*, which would have also found the same Point for the Centre of the *Parallel*, whose *Radius* is equal to the *Tangent* of its Distance from its *Pole*, by Cor. 1. and 2. of *Probl. 2. of Spherick Geometry*.

These *Parallels* in this *Projection*, are also *Almicanters*, or *Parallels of Altitude*.

$\odot$ ,  $\wp$ , is the *Ecliptick*, which must be divided from the Division on the Scale of *Half-Tangents*, but denominated according to the *Signs* of the *Zodiac*, reckoning 30 Degrees to each *Sign*.

The Stereographick Projection on the Plane of the Equinoctial.



Let S C be the *Meridian* and *Solstitial Colure*, E N the *Equinoctial Colure* and *Hour Circle* of 6.

P the *North Pole*.

$\odot$   $\ominus$  the *Northern Tropick*.

E  $\odot$  N the *Northern Half of the Ecliptick*, (whose Centre is found by setting off the *Secant* of 23 Deg. 30 Min. from  $\odot$ ) And its *Pole* is at a the Intersection of the *Polar Circle* and *Meridian*; and is the Place through which all Circles of *Longitude* must pass.

E Z N the *Horizon* of London, which is described thus: Set the *Half Tangent* of the *Co-latitude* from P to Z; then the *Tangent* of the same, set from P to O, or its *Secant* from Z to O, gives its Centre; and its *Pole* will be at b, 38 Deg. 30 Min. (in the *Half Tangents*) distant from F, where b is at the *Zenith*.

To draw any other Circles in this *Projection*.

1. For *Circles of Longitude*, which must all pass thro' a, and the several *Degrees* of the *Ecliptick*; set therefore the *Tangent* of 66 Deg. 30 Min. from a, downwards, on the *Meridian*, produced; which will find a Point, through which a *Perpendicular* drawn to the *Meridian*, shall contain in it the Centres of all the *Circles of Longitude*, whose Distances set off to the *Radius* P a, shall be the *Tangents* of the *Degrees* of their Distances from the *Meridian*, S P C, (which is that belonging to 180. Deg.)

2. All *Parallels of Declination* are drawn by setting the *Half-Tangents* of their Distances from P.

3. All *Azimuths*, or *Vertical Circles*, must pass thro' b at the *Zenith*; Since therefore the *Zenith* is 38 Deg. 30 Min. distant from P, set the *Co-secant* of that (or the *Secant* of 51 Deg. 30 Min.) from

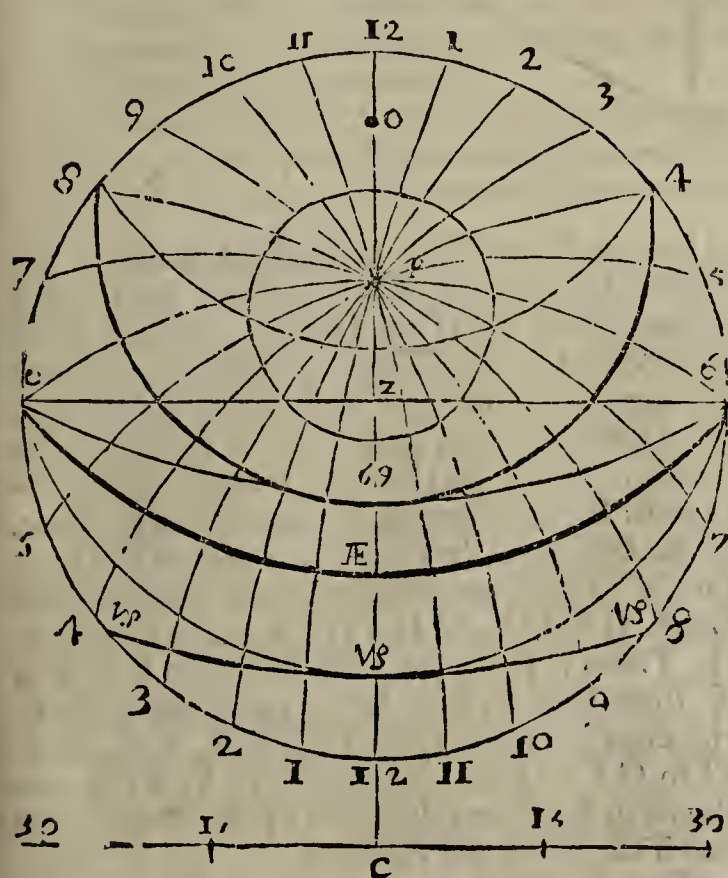


from *b* on the *Meridian* extended below, and that shall find the Point *x*, the Centre of the *Azimuth* of East and West, viz. E *b* N; and the Centres of all the rest are in a Line that's perpendicular to the *Meridian*, and drawn through *x*.

4. *Circles of Altitude*, or *Almicanters* are lesser Circles, whose *Poles* are not in the Plane of the *Projection*, and may be described by our Third Case of *Probl. 9. of Spherick Geometry*. Thus the Circle *Oe* is a *Parallel of Altitude* 50 Degrees above the *Horizon*.

5. All *Hour-Circles* are strait Lines from the Centre to the Limb.

*The Stereographick Projection on the Plane of the Horizon.*



First, Draw a Circle representing the *Horizon*, and quarter it with two *Diameters*.

Then will

$z$  be the *Zenith* of the Place.

12 2 12 the *Meridian*.

626 the *Prime Vertical*, or *Azimuth* of E. & W.

## Make

$\approx P = \frac{1}{2}$  Tangent of  $38^{\circ} 30'$  (or Tangent of  $19^{\circ} 15'$ )

P shall be the *Pole of the World*.

## Make

$$z AE = \frac{1}{2} \text{ Tangent of } 51^{\circ} 30' \text{ (or Tangent of } 25^{\circ} 45')$$

And

$\begin{array}{l} \text{Æ} \circ = \text{Secant} \\ \text{z} \circ = \text{Tang.} \end{array} \left. \vphantom{\begin{array}{l} \text{Æ} \circ \\ \text{z} \circ \end{array}} \right\} \text{of } 38 \text{ Deg. } 30 \text{ Min.}$

Then shall

*o* be the Centre of the Equinoctial 6 Æ 6.

In this *Projection*, *Almicanters* are all parallel to the Primitive Circle.

And *Azimuths* are all Right Lines, passing thro' (z) the Centre of the Primitive, to the equal Divisions in the Limb.

*Parallels of Declination*, are all Lesser Circles, and parallel to the *Equinoctial*; and their Intersection with the Meridian are found by setting the Half Tangent of their Distance from the *Zenith* Southward and Northward, or both ways from *z*.

Their Centres are found by biseſting the Diſtance between thoſe two Points; for the Middle ſhall be the Centre of the Parallel.

Thus,

$\angle \textcircled{\text{S}} = \frac{1}{2} \text{Tang. of } 28^{\circ} 00' = \text{Distance}$   
 of the Tropick of  $\textcircled{\text{S}}$  from the *Zenith*,

And

$\angle \textcircled{\text{W}} = \frac{1}{2} \text{Tangt. of } 75^{\circ} 00' = \text{Dist.}$   
 of the Trop. of  $\textcircled{\text{W}}$  from the *Zenith*

} to the  
 Southw.  
 or down-  
 ward  
 from  $\angle$ .

And the Interfection again with the North of the *Meridian*, is at

$\left. \begin{array}{l} 105^{\circ} \quad 30' \\ 152^{\circ} \quad 0' \end{array} \right\} \text{for } \left\{ \begin{array}{l} w \\ \phi \end{array} \right\} \text{ to the Northwards, or up-} \\ \text{wards from } z.$

For the *Hour-Circles*

Make  $zc$  = Tangent of  $51^{\circ} 30'$ , or  $Pc$  = Secant of  $51^{\circ} 30'$ . Draw  $GCT$  perpendicular to the produced *Meridian*. Wherefore, if from  $c$ , with the Radius  $zc$ , you set off the Tangents of  $15^{\circ}, 30^{\circ}, 45^{\circ}$ , &c. both ways, you'll have the Centres of the several *Hour-Circles*, 7 and 5, 8 and 4, &c.

Note, *In all Stereographick Projections, all Diameters are measured on the Scale of Half Tangents : The Reason of which you have in Prop. 2. of our Spherick Projection. And this is the Ground of all Dyalling, or the True Projection of the Hour-Circles of the Sphere on any Given Plane.*

PROHIBITIO *de vasto directa parti*, is a Writ Judicial directed to the Tenant, prohibiting him from making Waste upon the Land in Controversie, during the Suit. It is sometimes made to the Sheriff.

PROHIBITION, is a Writ to forbid any Court, either Spiritual or Secular, to proceed in any Cause there depending, upon Suggestion that the Cognizance thereof belongeth not to the same Court : But is now most usually taken for that Writ which lieth for one that is impleaded in the *Court Christian*, for a Cause belonging to the Temporal Jurisdiction, or the Conusance of the King's Court ; whereby as well the Party and his Council, as the Judge himself, and the Register, are forbidden to proceed any farther in that Cause.

PROJECTILES, are such Bodies, as being put into a violent Motion by any great Force, are then cast off or let go from the Place where they received their Quantity of Motion, and do afterwards move at a Distance from it; as a Stone thrown out of ones Hand, or by a Sling, an Arrow from a Bow, a Bullet from a Gun, &c.

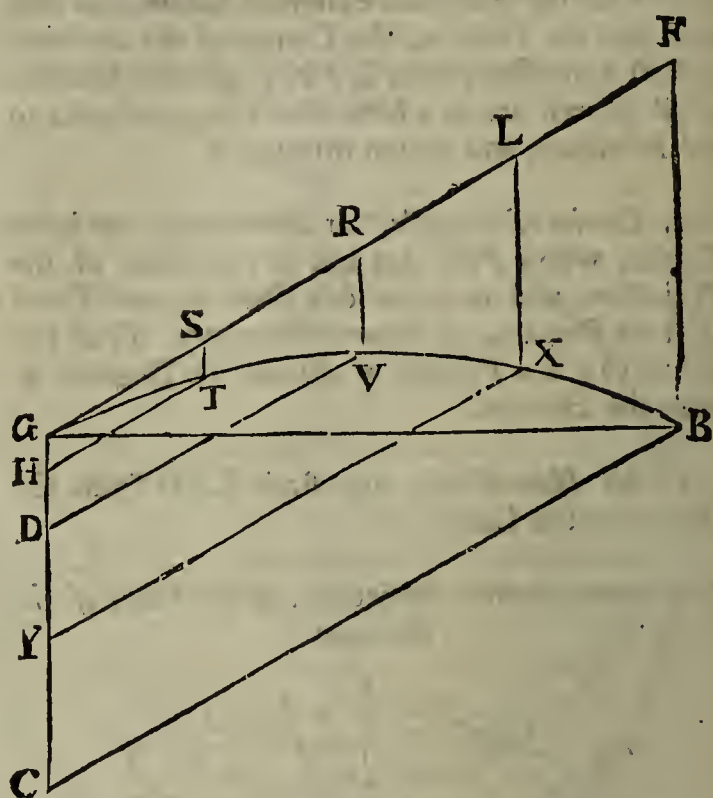


There hath been a great Dispute about the Cause of the Continuation of the Motion of *Projectiles*, or what it is that makes them move after they part from the Force that began the Motion. The *Peripateticks* will needs have it, That the Air being by the Motion of the Hand of the Slinger, &c. put into a most violent Agitation, and forced rapidly to follow the Motion of the Stone, while 'tis accelerated in the Hand of the Slinger, doth, to prevent a *Vacuum*, prefs with all due Velocity after the Stone when it parts from the Hand, and thrusts it forwards as long as it can. But this Account seems very unconceivable; and there needs nothing more to solve the Motion of *Projected Bodies*, but only to consider, That all Bodies being indifferent to Motion or Rest, will necessarily continue the State which they are put into, unless they are forced to change it by some other Force impressed upon them. Thus if a Body be at rest, so it will eternally abide, if nothing move it; or if it be in Motion, so it will eternally move uniformly on in the same right Line, if nothing stop it. Wherefore, when a Stone is put into any Degree of Motion, by the Rotation of the Arm of the Man that flings it, whatever Degree of Velocity it had acquired when it parted from the Hand, the same would it ever after keep if it moved in *Vacuo*, and had no Gravity: But because it hath a Tendency, as all Bodies (by the Law of Nature) have, towards the Centre of the Earth, and is also resisted by the Air all along as it goes, in proportion to its Velocity; it plainly follows, that it must needs be both continually drawn downwards, and also continually retarded in its Progressive Motion forwards, and consequently at last fall down to the Earth, and stop.

The Line of Motion which a Body *projected* describes in the Air, (abstracting from the Resistance of the Medium) is, as hath been proved by *Gallileus*, and many others, and particularly by our *Sir Isaac Newton*, *Prop. 4. Cor. 1.* of his Second Book, the Curve of a *Parabola*: Which Line is also described by every descending Body.

He shews also, That if the Line of Direction of the Projectile Motion of any Body, the Degree of its Velocity, and at the Beginning, the Resistance of the Medium being given, the Curve which it will describe may be discovered, and *vice versa*; he saith also in *Schol. Prop. 10. Lib. 2.* That the Line which a *Projectile* describes in a Medium uniformly resisting the Motion, rather approaches to an *Hyperbola* than a *Parabola*.

The Learned Capt. *Halley*, proves all *Projectiles* to describe a *Parabola* thus:



Let the Line *G R F* be the Line in which the *Project* is directed, and in which, by the first *Axiom*, under the Word *Descent*, it would move equal Spaces in equal Times, were it not deflected downwards by the Force of *Gravity*. Let *GB* be the *Horizontal Line*, and *GC* a Perpendicular thereto. Then the Line *G R F* being divided into equal Parts, answering to equal Spaces of Time, let the *Descents* of the *Projects* be laid down in Lines parallel to *GC*, proportioned as the Squares of the Lines, *GS, GR, GL, GF*, or as the Squares of the Times; (*i. e.*) let them be drawn from *S* to *T*, from *R* to *V*, from *L* to *X*, and from *F* to *B*, and draw the Line *TH, VD, XY, BC*, parallel to *GF*; I say, the Points *T, V, X, B*, are Points in the Curve described by the *Project*, and that That Curve is a *Parabola*.

That the Points are in the Curve, is evident by *Axiom 2.* under the Word *Descent of Heavy Bodies*: and the Parts of the *Descent* *GH, GD, GY, GC=ST, RV, LX, FB*, being as the Squares of the Times, (by *Prop. 2.* under the Word *Descent*) that is, as the Square of the *Ordinates* *HT, DV, YX, BC = GS, GR, GL, GF*, the Spaces measured in those Times; and there being no other Curve but the *Parabola*, whose Parts of the *Diameter* are as the Squares of the *Ordinates*, it follows that the Curve described by a *Project* can be no other than a *Parabola*: And saying, as *RV* the *Descent* in any Time, is to *RG* or *VD* the direct Motion in the same Time; so is *VD* to a Third Proportional, or the *Parameter* of the *Parabola* to the *Diameter* *GC*, which is always the same in *Projects* cast with the same Velocity: And the Velocity being defined by the Number of Feet moved in a Second of Time, the *Parameter* will be found by dividing the Square of the Velocity by 16 Foot 1 Inch, the Fall of a Body in the same Time.

**PROJECTURE**, a Term in Architecture signifying the Jutting or Leaning-out of any Part of a Building, the Coping of a Wall, &c. These the *Italians* call *Sporti*, and the *Greeks*, *Echphoras*; and in the general, all Margents which hang over beyond the Scapus of a Column, are called *Projectures*.



**PRO** *Indiviso*, is a Possession or Occupation of Lands or Tenements, belonging to two or more Persons, whereof none knows his several Portion, as *Co-parceners* before Partition.

**PROLABIA**, the utmost prominent Parts of the Lips.

**PROLAPSUS Uteri**. See *Uteri Prolapsus*.

**PROLATE Spheroid**, is a Solid produced by the Revolution of a Semi-Ellipsis about its *longer* Diameter; but if a Solid be formed by the Revolution of a Semi-Ellipsis about its *shorter* Diameter; 'tis then called an *Oblate Spheroid*: And of this Figure is the Earth we inhabit, and perhaps all the Planets are so too, having their *Equatorial* Diameter longer than their *Polar*.

**PROLATION**, [in *Musick*] the Art of Shaking, or making several Inflections of the Voice on the same Syllable.

**PROLEPSIS**, [*πρόληψις*, Gr.] is a Figure in Rhetorick, by which we prevent what might be objected by the Adversary.

**PROLEPTICUS**, is a Disease always anticipating; so as if the Ague came to day at Four of the Clock, then to Morrow one Hour sooner, and so on. *Blanchard*.

**PROLOCUTOR** of the *Convocation House*, is an Officer chosen by Persons Ecclesiastical, publickly assembled by Virtue of the King's Writ, for every Parliament: And as there be two Houses of *Convocation*, so there are two *Prolocutors*, one of the Lower, and one of the Higher House. He of the Lower House, presently upon the first Assembly, by the Motion of the Bishops, being chosen by the Members of the said Lower House, is presented to the Bishops for *Prolocutor*, that is, the Person by whom they intend to deliver their Resolutions to the Higher House, and to have their own House especially ordered and governed. His Office is to cause the Clerk to call the Names of such as are of that House, when he sees Cause to read all things propounded, gather Suffrages, and the like.

**PROMONTORY**, is an Hill or High Land running out into the Sea: The Extremity of which towards the Sea, is usually called a *Cape* or an *Head-land*.

**PROMOTERS**, or *Promoters*, are those who in popular and penal Actions do prosecute Offenders in their own Name and the King's; having Part of the Fines or Penalties for their Reward. They do belong especially to the *Exchequer* and *King's Bench*.

**PROMULGE** a Law, is first to make a Law, and then to declare, publish, and proclaim the same to Publick View; and so it is *Promulgated*.

**PRONOS**, or *Pronaus*, a Term used by Architects for a Church-Porch, or a *Pertico* to a Palace, great Hall, or spacious Building.

**PRONATOR Radii Quadratus**, is a Muscle of the *Radius*, which ariseth broad and fleshy from the lower and inner Part of the *Ulna*; and passing transversly over the Ligament that joins the *Radius* to the *Ulna*, is so inserted to the Superior and External Part of the *Radius*: It helps with the *Pronator Teres* to move the *Radius* inwardly.

**PRONATOR Radii Teres** is a Muscle of the *Radius*, by some called *Pronator Superior Rotundus*: It ariseth fleshy from the Internal Extuberance of the *Os Humeri*, where those bending the *Carpus* and Fingers do arise; and firmly adhering to the

*Flexor Carpi Radialis*, it descends obliquely downwards to its fleshy Insertion, a little above the middle of the *Radius* externally: Its Use is to move the *Radius* inwards.

**PRONOTARY**, or *Protonotary*, is a Chief Officer of the *Common-Pleas* and *King's-Bench*. He of the *King's Bench* records all Actions Civil sued in that Court, as the *Clerk* of the *Crown-Office* doth all Criminal Causes. Those of the *Common-Pleas* do enter and enrol all manner of Declarations, Pleadings, Assises, Judgments and Actions: Also they make out all Judicial Writs, as the *Venire facias*, after Issue joined; and *Habeas Corpus*, for bringing in of the Jury; and *Disstringas Jurator*. They also make out Writs of Execution and Seisin; Writs of *Superfedeas*, for Appearance to *Exigents*: as well as the *Exigents* and *Writ of Privilege*, for removing Causes from other Inferior Courts of Record, where the Party hath Cause of Privilege: Also Writs of *Procedendo* and *Scire facias* in all Cases, and Writs to enquire of *Damages*, and all Processes upon *Prohibitions*, and upon Writs of *Audita Querela*, and *False Judgment*; with many other. Lastly, They enrol all Recognisances acknowledged in that Court, and all Common Recoveries; and they make Exemplifications of any Record in the same Term, before their Rolls are made up and delivered into the Treasury of the Records of that Court.

**PRONOUN**, in *Grammar*, is a variable Word, often used as a Noun, and nearly of a like Signification with it: And these *Pronouns* they divide into such as are,

1. *Finite*; as, *I, Thou, He, &c.*
2. *Infinite*; as *Quis, Cujus, &c.*
3. *Demonstrative*, which shew a present Person or Thing; as, *I, You, He, &c.*
4. *Relative*, which refer to some antecedent Word; as, *who, which, &c.*
5. *Interrogative*; as *when, who* and *which, &c.* are used in asking Questions.
6. *Possessives*; as, *Mine, Thine, &c.*
7. *Gentiles*, which express a Nation or Country; as, *Nostras, Vestras, Cujas*, in the *Latin Tongue*.

**PRONOUNCING**, *Pronunciation*, [in *Painting*] the Marking and Expressing the Parts of all kinds of Bodies, with that Degree of Force necessary to make them more or less distinct and conspicuous.

**PRO Partibus Liberandis**, is a Writ for the Partition of Lands between Co-heirs.

**PROPER Fraction**, is such a one as hath its Numerator less than the Denominator; as  $\frac{3}{4}$ ,  $\frac{5}{7}$ , which is really less than Unity, and therefore properly speaking, a Fraction.

**PROPER Navigation**, is the guiding of a Ship to any Port desired, where the Voyage is to be perform'd in the vast Ocean; and requires not only the Lead-Line, and ordinary Compass, but *Azimuth-Compass*, *Charts*, *Log-board*, and *Half Minute-Glass*; with Instruments for Celestial Observation, as the *Quadrant*, *Fore-Staff*, &c. And the Navigator must be able by these to find at any time in what Place the Ship is; which is done by comparing it with any known Place; that is, how much the same known Place is situate from the Ship, either towards the North or South, which is called



the *Difference of Latitude*; or towards the East or West, which if in proper Degrees, is called the *Difference of Longitude*.

PROPERTY, or *Propriety*, strictly speaking, is the highest Right that a Man hath or can have to any thing, and no ways depending upon any other Man's Courtesie: And this, none in our Kingdom can be said to have in any Lands or Tenements, but only the King in the Right of his Crown; because all the Land throughout the Realm is in the Nature of Fee, and held either mediately or immediately of the Crown.

This Word nevertheless is used for that Right in Lands and Tenements that Common Persons have, because it importeth as much as *utile Dominium*, tho' not *Directum*. And there are Three manners of Rights of Property, that is, Property *Absolute*, Property *Qualified*, and Property *Possessory*.

PROPHASIS, is a Fore knowledge in Diseases, also an Occasion or Antecedent Cause. *Blanch*.

PROPHYLACTICA, [*προφυλακτική*, Gr.] is a Part of that Part of Physick called *Hygieina*, (or what respects the Preservation of Health) which gives Notice of future but imminent Diseases. *Blanchard*.

PROPLASM, [*πρόπλασμα*, Gr.] the same with a Mould in which any Metal or soft Matter, which afterwards will harden, is cast.

PROPLASTICE, [*πρόπλαστική*, Gr.] the Art of making Moulds for casting Things in.

PROPORCITAS, in Law, signifies the Declaration or Deliverance of an Affise; otherwise called *Verdictum Affisæ*, the Verdict of an Affise; because the Assisors are sworn to declare the Truth, and therefore are called *Juratores* or *Jurors*.

PROPORTION, 1. When two Quantities are compar'd one with another, in respect of their Greatness or Smallness, that *Comparison* is called *Ratio*, *Reason*, *Rate*, or *Proportion*: But when more than two Quantities are compared, then the Comparison is more usually called the *Proportion* that they have to one another. The Words *Ratio* and *Proportion* are frequently used promiscuously.

2. When two Quantities only are compared, the former Term is called the *Antecedent*, and the latter the *Consequent*.

3. And the *Proportion* or Relation of two Numbers to one another, is found by dividing the *Antecedent* by the *Consequent*; and the Quotient is the Exponent or Denominator of the Proportion.

As, if the Quotient be 2, the Proportion is Double; if 3, Treble; if 4, Quadruple; if  $\frac{1}{2}$ , Subduple, or one Half; if  $\frac{1}{3}$ , Subtriple, or one Third part; if  $\frac{3}{2}$ , or  $1\frac{1}{2}$ , Sesquialteral, or the Proportion denominated by one and an Half; if  $\frac{4}{3}$ , or  $1\frac{1}{3}$ , Sesquitercian, or once with a Third part; and universally, the Proportion of A to B, is that denomi-

A

nated by  $\frac{A}{B}$ , that is, by the Quotient of A divided by B.

4. These *Proportions*, so many of them as are Rational, or between Number and Number, have particular Names given them by *Greek* and *Latin* Writers.

If after the Antecedent be divided by the Consequent, the Quotient be 1, it is called *Proportion of Equality*, or *Simple Proportion*.

If the Quotient be 2, 3, 4, (or such other Integer Number) it is called *Multiple Proportion*, (viz. *Double*, *Treble*, *Quadruple*, &c.) And the contrary to those are called *Submultiple*, (viz. *Subduple*, *Subtriple*, *Subquadruple*, &c.) or *One half*, a *Third part*, *Fourth part*, or other such *Aliquot* Part.

If the Quotient be 1, with one such Part, as  $1\frac{1}{2}$ ,  $1\frac{1}{3}$ ,  $1\frac{1}{4}$ , &c. it is called *Superparticular*, (viz. *Sesquialteral*, *Sesquitercian*, *Sesquiquartan*, &c.) And the Contraries hereunto are called *Subsuperparticular*, (viz. *Subsesquialteral*, *Subsesquitercian*, &c.)

If such Quotient be 2, 3, 4, (or such other Integer greater than Unity) with such an *Aliquot* Part, it is called *Multiple-superparticular*, (as  $2\frac{1}{2}$ , *Duple-sesquialteral*;  $3\frac{1}{3}$ , *Triple-sesquitercian*;  $3\frac{1}{4}$ , *Triple-sesquiquartan*, &c.) And the Contraries thereunto are *Submultiple-superparticular*, as *Subduple-sesquialteral*, *Subtriple-sesquitercian*, &c.

If the Quotient be 1, with some Number of *Aliquot* Parts, as  $1\frac{2}{3}$ ,  $1\frac{3}{4}$ ,  $1\frac{2}{5}$ , &c. it is called *Superpartient*, (as *Superbipartiens tertias*, *Supertripartiens quartas*, *Superbipartiens quintas*, &c.) And the Contraries hereunto are *Subsuperpartient*, as *Subsuperbipartiens tertias*, &c.

If such Quotient be some greater Integer Number, (as 2, 3, &c.) with such Number of *Aliquot* Parts, as  $2\frac{2}{3}$ ,  $3\frac{3}{4}$ ,  $3\frac{2}{5}$ , &c. it is called *Multiple-superpartiens*, (as *Dupla superbipartiens tertiens*, *Tripla supertripartiens quartas*, *Tripla superbipartiens quintas*, &c.) And the Contraries thereunto, *Submultiple-superpartient*, (as *Subdupla superbipartiens tertias*, *Subtriple supertripartiens quartas*, &c.) As that of 31 to 7, (because  $\frac{31}{7} = 4\frac{3}{7}$ ) is *Quadruple-supertripartiens septimas*; and its Contrary, 7 to 31, is *Subquadruple-supertripartiens septimas*.

And under some of these Compellations all Proportions will fall, which are as one Integer Number to another.

But notwithstanding all this ado, (tho' that the ancient Geometers may be understood, I thought fit to explain these long, barbarous, and hard Words here) 'tis much better, and more intelligible, to express these Proportions, as the usual manner now is, by the Numbers themselves, than by these Names; and briefly and clearly to say, as 31 is to 7, or as 7 is to 31, rather than to say *Quadrupla-supertripartiens septimas*, or *Subquadrupla-supertripartiens septimas*.

5. If when four Quantities are considered, you find that the *First* hath as much Greatness or Smallness, in respect of the *Second*, as the *Third* hath in respect of the *Fourth*: Those four Quantities are called *Proportionals*, and are thus expressed,

$$8 . 2 :: 16 . 4 .$$

$$a . b :: c . d .$$

That is, As 8 contains 2 four times, so 16 contains 4 four times; and therefore 8 is just as big in respect of 2, as 16 is in respect of 4.

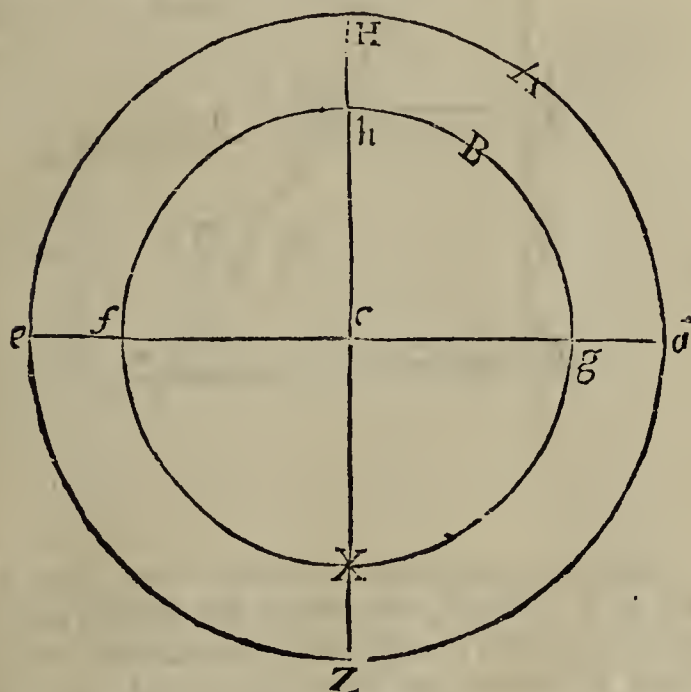
Here therefore, the *Ratio* between the First Pair, is equal to the *Ratio* between the other Pair of Numbers; and consequently, these Four having equal *Ratio's*, are *Proportionals*.

But if you encrease or diminish any one of these Four Numbers, the *Ratio* will grow unequal, and then they will not be *Proportionals*: As if instead of 8 you should put 9 or 7, letting all the rest remain



main as they were; 'twill then be plain, that 9 hath more Magnitude, and 7 hath less in respect of 2, than 16 hath in respect of 4; for 9 contains 2 above four times, and 7 doth not contain it so often as four times; whereas 16 contains 4 exactly four times: Wherefore these latter Numbers, 9, 2, 16, 4, or 7, 2, 16, 4, are not *Proportionals*. And 'twould be the same, if any other Member of the first Four Numbers had been altered; for the *Proportion* would necessarily be destroyed.

6. The annexed Figure will serve very well to explain *Proportion*.



Let the *Radius*  $eC$  be suppos'd to move quite round on its Centre  $C$ , 'till the Point  $e$  come to the same Place it was at before it began to move; then will that Point  $e$  have described the Circumference of a Circle, which let be  $HdZe$ . Then at the same time, any other Point of the *Radius*, as suppose  $f$ , will also have described the Inner Circle  $fbgx$ . Draw the two Diameters  $HZ$ , and  $ed$ , cutting each other at Right Angles in  $C$ , which will divide both Circles into four Quadrants. 'Tis plain from hence, that the same Proportion which the outer Circle ( $Z$ ) bears to its fourth (or any other) part  $A$ ; the same must the inner Circle ( $X$ ) bear to  $B$ , a like Part of its Circumference. For when the longer *Radius*  $eC$  hath moved over the fourth Part of the Circle  $Z$ , and the Point  $e$  is come to  $H$ ; then will the Point  $f$  also be come to  $h$ , and will have gone over a Quadrant of its Circle  $X$ ; and when  $e$  is come to  $d$ ,  $f$  also will be come to  $g$ , and will as well as the other have described a Semi-circle: So that as the Circle  $Z$  is to any Part of its Periphery, or as it is to the Ark  $A$ ; so will the Circle  $X$  be to a like Part of its Periphery, or to the Ark  $B$ . That is,

$$\begin{array}{cccc} 12 & 3 & 8 & 2 \\ Z & : & A & :: X : B. \end{array}$$

7. And from these Considerations may all the several Species of Proportion be demonstrated from the Nature of the Thing. For if

$$\begin{array}{cccc} 12 & : & 3 & :: 8 : 2. \\ Z & : & A & :: X : B. \end{array}$$

It will certainly follow by *Inversion*, that

$$A : Z :: B : X.$$

That is, If  $Z$  be as big in respect of  $A$ , as  $X$  is in respect of  $B$ ; then must  $A$  be as little in respect of  $Z$ , as  $B$  is in respect of  $X$ .

Or if 12 contain 3 as often as 8 contains 2, then will 3 be contained in 12 as oft as 2 is contained in 8.

8. Since  $Z : A :: X : B$ , it will follow, by *Alternate Proportion*, that  $Z : X :: A : B$ ; that is, Antecedent is to Antecedent, as Consequent is to Consequent: Which is plain, if the former Figure be well considered.

For suppose the outer Circle  $Z$  to be Double, Triple, Quadruple, &c. of the inner Circle  $X$ ; then must the Ark  $A$  (or any other Part of it) be Double, Triple, &c. of the Ark  $B$ , a like Part of the Circle  $X$ . Therefore, as the Whole is to the Whole, so the Parts must be to the Parts; that is,  $Z : X :: A : B$ . *Q. E. D.*

9. If you compare the *Differences* (which is what remains when one is subtracted from the other) between the Antecedents and their Consequents, with those Consequents; another Species of *Proportion* will be found, which is called *Proportion by Division*, and ought to be thus exprest,

$$\frac{Z - A}{Z} : A :: \frac{X - B}{X} : B.$$

Now undoubtedly, if from the whole Circle  $Z$  you take a Quarter, (or any other Part) as  $A$ ; and also from the whole Circle  $X$  you take a Quarter, or any like Part, as  $B$ ; the remaining three Quarters of the outer Circle, must be to its other Quarter  $A$ , as the remaining three Quarters in the inner Circle are to its Quarter  $B$ . That is,

$$\begin{array}{cccc} \frac{Z - A}{9} & : & A & :: \frac{X - B}{6} : B. \quad \text{Q. E. D.} \\ 9 & : & 3 & :: 6 : 2 \end{array}$$

10. Or if you add the Antecedents and Consequents together, and then compare the Sums with the former Consequents; another Species arises, called *Proportion by Composition*; and 'tis thus exprest,

$$\frac{Z + A}{Z} : A :: \frac{X + B}{X} : B.$$

And 'tis certain, since  $Z : A :: X : B$ , by the Supposition, and also  $Z : X :: A : B$ , by *alternate Proportion*:  $Z$  and  $A$  together will be to  $A$ , as  $X$  and  $B$  together are to  $B$ . That is,

$$\begin{array}{cccc} \frac{Z + A}{15} & : & A & :: \frac{X + B}{10} : B. \quad \text{Q. E. D.} \\ 15 & : & 3 & :: 10 : 2 \end{array}$$

11. If you compare the Antecedents with the Differences between them and their Consequents, another Species of Proportion arises, which is called *Conversion of Proportion*: And is thus exprest,



$$12 : 9 :: 8 : 6$$

$$Z : Z - A :: X : X - B$$

Which is very plain from the Consideration of the Figure; for no doubt the whole Circle Z is to its  $\frac{3}{4}$  (*viz.* Z—A) as the whole lesser Circle X is to its  $\frac{3}{4}$  (which is X—B.)

$$12 : 3 :: 8 : 2$$

12. If when  $Z : A :: X : B$ , you compare the Consequents A and B with two other Quantities, so as to make two Rows of Proportionals standing thus,  $Z : A :: X : B$ .  
 $A : d :: B : I$ .

$$12 : 9 :: 8 : 6$$

Then will Z be to  $d ::$  as X : I, which is another Species of Proportion by *Equality*, or *ex æquo ordinata*. And follows from this Figure very plainly; for no doubt the whole Circle Z is to its  $\frac{3}{4}$ , which is 9 or  $d ::$  as the whole Circle X is to its  $\frac{3}{4}$ , which is I. or 6.

13. If Z be taken as often as X, *ex. gr.* 3 Z and 3 X, you may conclude, That  $Z : X :: 3 Z : 3 X$ , or as 10 Z to 10 X; or also as  $12 \frac{1}{2}$  Z to  $12 \frac{1}{2}$  X. And so on; in whatsoever Proportion the two Magnitudes Z and X are multiplied; so they are multiplied equally; or that you take one as often as you take the other. For then there will be the same Proportion between the Magnitudes thus equally multiplied, as there was between the Simple Magnitudes, before such Multiplications.

And these Magnitudes thus equally multiplied, are called *Equi-multiples* of the simple Magnitudes Z and X: Hence we say, that *Equi-Multiples* are in the same Proportion as such simple Magnitudes, out of which they are compounded.

14. If Z be divided in the same manner as X is; and *ex. gr.* you take a fourth Part of Z, and the like of X; or the tenth; or any other Part of Z, and the same of X: Then will these Parts be proportional to their Wholes,  $Z : X :: \frac{1}{4} Z$  (or  $\frac{1}{10} Z$ ) :  $\frac{1}{4} X$  (or  $\frac{1}{10} X$ ). All which is self-evident.

15. A *Proportion* is said to be *Compounded* of other Proportions, when the Exponent of That is made by the Multiplication of the Exponents of These, one into another. Thus, the *Compound of the Treble and Double*, (whose Exponents are 3 and 2) is the *Treble of the Double*, (whose Exponent is  $3 \times 2$ ) that is, the *Sextuple* (because  $3 \times 2 = 6$ ) which is manifestly a Work of Multiplication.

16. The *Products*, or the *Quotients* of any two Quantities or Numbers *Multiplied* or *Divided* by the same third Numbers, are in the same Proportion as the Numbers were before they were *Multiplied* or *Divided*.

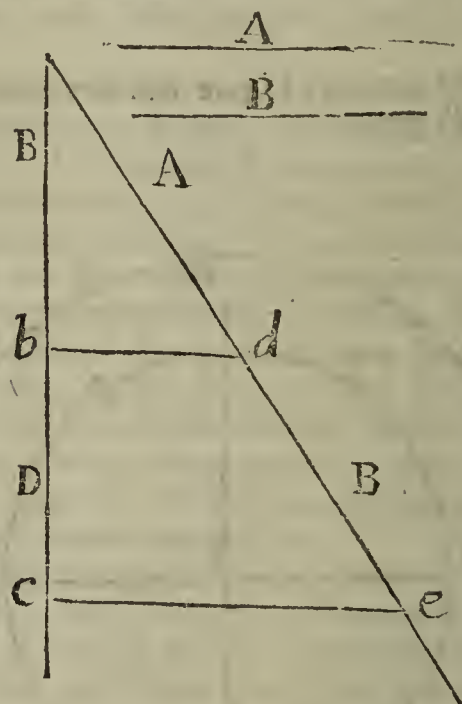
*E. gr.* 1. Let 8 and 12 be multiplied by 4; then will  $8 : 12 :: 32 : 48$ .

2. Let 8 and 12 be divided by 4; then will  $8 : 12 :: 2 : 3$ .

The Reason of which is very plain; because one Number is just as much increased by Multiplication or diminished by Division, as the other is.

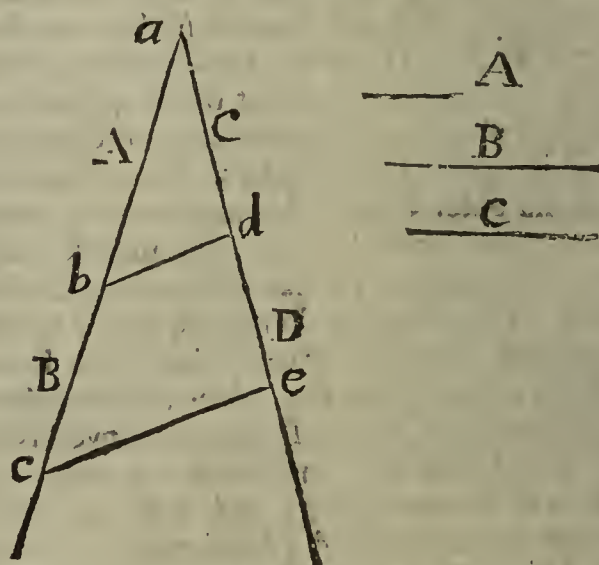
### PROBLEMS.

To Two Lines A and B, to find D a Third Proportional.



Make any Right-lined Angle, as  $cae$ . Then set off in it  $ad = A$ , and  $ab = B$ . Set off also B again from  $d$  to  $e$ ; then join  $b$  and  $d$ , and to  $bd$ , draw a Parallel thro' the Point  $e$ , so shall  $bc$  be the Line sought for,  $A : B :: B : D$ , by *2 e 6 Euclid*.

To Three given Lines, A B and C, to find a Fourth Proportional D.



Make any Angle, as  $ace$ ; then from  $a$ , take  $ab = A$ , and  $bc = B$ , and  $ad = C$ , join  $bd$ , and thro'  $c$  draw a Parallel to  $bd$ ; so shall  $de$  be the Line sought: For  $A : B :: C : D$ . *2 e 6 Euclid*.

### Of the Proportion of Figures.

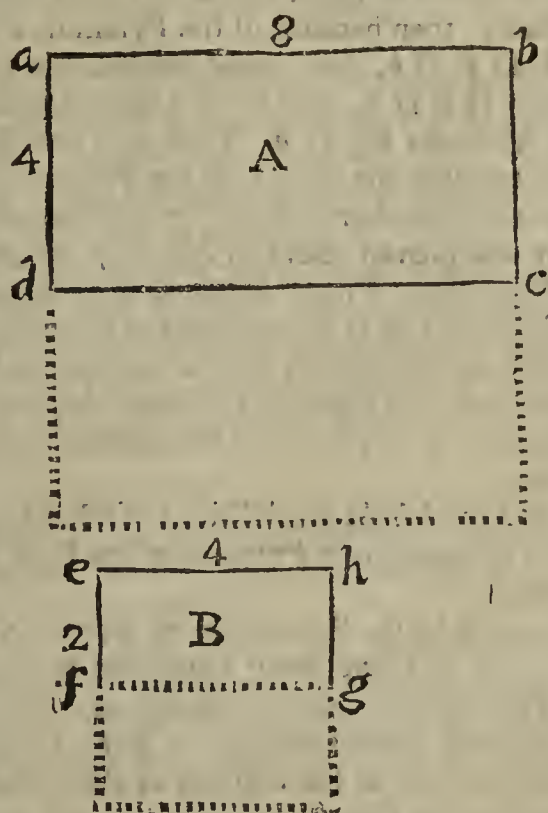
1. To find the Proportion that one Rectangle hath to another, both Length and Breadth must be considered.



For Rectangles are to each other as the Products of their respective Lengths multiplied by their Breadths.

Thus, if there be two Rectangles, the former of which hath its Lengths 5 Inches, Yards, &c. and its Breadth 3 Inches, Yards, &c. and the latter had its Length 8 Inches, Yards, &c. and its Breadth 4 Inches, Yards, &c. Then the Rectangles will be to each other, as  $3 \times 5 (= 15)$  is to  $4 \times 8 (= 32)$  *i. e.* as 15 is to 32. So that all Rectangles are to one another in a Ratio compounded of that of their Sides.

2. When Rectangles have their Sides proportionable, (so that  $a b : e h :: a d : e f$ ) then is the Rectangle A, to the Rectangle B, in a duplicate Proportion to the Ratio of the Sides.



For the Ratio of A to B, in compounded of the Ratio of  $a b$  to  $e h$ , and of the Ratio of  $a d$  to  $e f$ .

But in this Case  $a b$  is to  $e h$ , in the very same Ratio as  $a d$  is to  $e f$ ; and therefore the Proportion of A to B being compounded of those two equal Ratio's, must be duplicate of the Ratio of their Sides to each other; that is, duplicate of the Ratio of  $a b$  to  $e h$ , or of  $a d$  to  $e f$ . Q. E. D.

### C O R O L L A R Y.

Hence all Triangles, Parallelograms, Prisms, Parallelopipeds, Pyramids, Cones and Cylinders are to one another respectively compared, in a Proportion compounded of that of their Heights and Bases.

3. All Triangles, and Parallelograms, Pyramids, Prisms, and Parallelopipeds; also all Cones and Cylinders, each Kind compared among themselves: If they have equal Altitudes, are in the same Proportion as their Bases: If they have equal Bases, are as their Heights.

For the Bases, or Heights, will severally be common Efficients or Multipliers; and therefore must make the Products be in the same Proportion as the Multiplicand was before.

Thus, if the equal Altitude of any two Triangles, Parallelopipeds, Cones, &c. be called  $a$ , and their unequal Bases  $b$  and  $d$ : Then by the 13th of Proportion (above)  $b. d :: a b. a d$ .

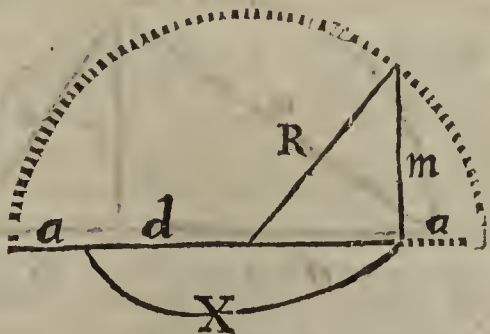
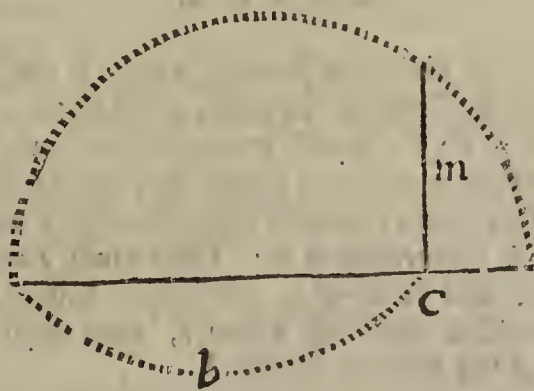
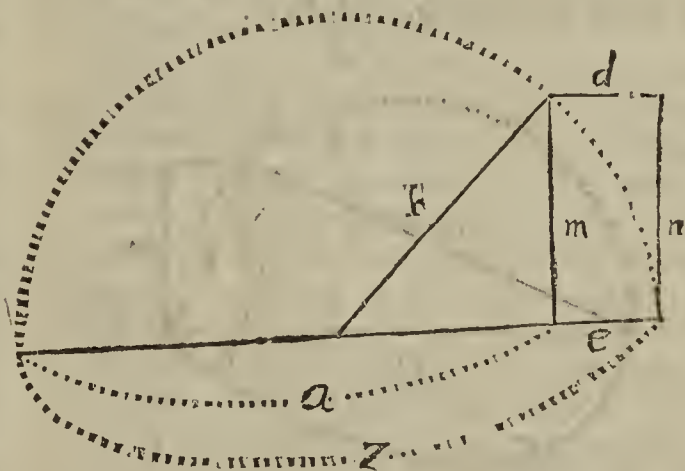
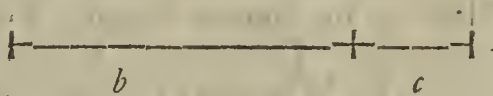
This Problem being of constant Use, ought to be placed among the Elements of Geometry.

### C A S E I.

To find two Right Lines, whose Sum and Difference is given, reciprocally proportional to Two given Lines.

Let the two given Lines be  $b$  and  $c$ , and let the Sum of the two Lines sought, be  $Z$ : 'Tis required to find a Point where  $Z$  may be so divided, as that  $b : a :: e : c$ .

First find  $m$  a mean Proportional between  $b$  and  $c$ , which erect perpendicularly at either End of  $Z$ : Draw  $d$  parallel to  $Z$ , and where it cuts the Circle let fall  $m$ , and draw  $R$ : Then, I say,  $a$  and  $e$  are the Segments required: For  $a e = m m = b c$ . Q. E. D.



### C A S E II.

Where the Difference =  $X$  is given, find  $m$  as before, which erect perpendicularly at either End of  $X$ .



X: Then draw R from the middle Point of X, and with it, as a Radius, describe a Semi-circle on the Center  $d$ : So shall  $a + X$  be the greater Line, and  $a$  the lesser sought: For  $a + X$ , multiplied by  $a = m m = b c$ . Q. E. D.

That is, in other Words, if you have the Extreams, and the Sum and Difference of 4 Proportionals, you may find the Terms severally.

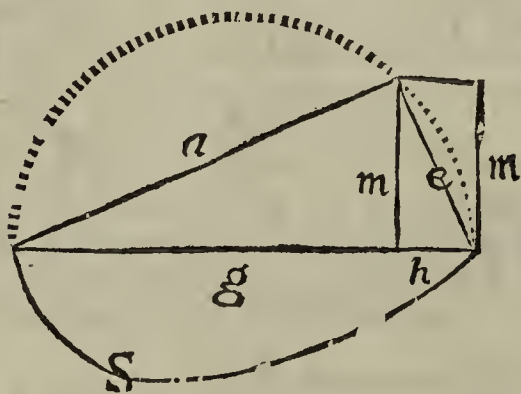
### PROBLEM II.

To find Two Squares, whose Sum or Difference is given reciprocally proportional to Two given Squares.

#### CASE I.

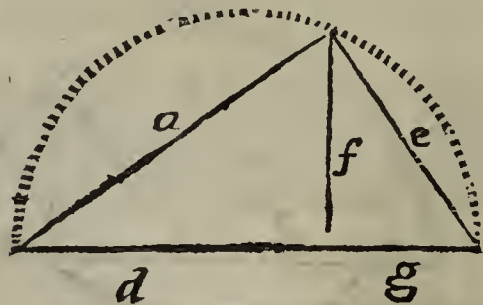
Let  $b$  and  $c$  be the Sides of the Squares given, and let  $S$  be equal to the Sum of the Squares required.

Find a fourth Proportional to  $S b$  and  $c$ ; which suppose to be  $d$ : Then, by the former Problem find 2 Lines reciprocally proportionable to  $b$  and  $c$ , whose Sum is  $S$ : As suppose the Segments  $g$  and  $h$ , and draw the Lines  $a$  and  $e$ , which shall be the Sides of the Squares sought. For since  $S : b :: c d$ . (or  $m$ ): Therefore by Similar Triangles,  $S : a :: e m$ . Wherefore *ex æquo* reciprocally  $b : a :: e : c$ . Wherefore their Squares will be also in the same Ratio. Q. E. D.



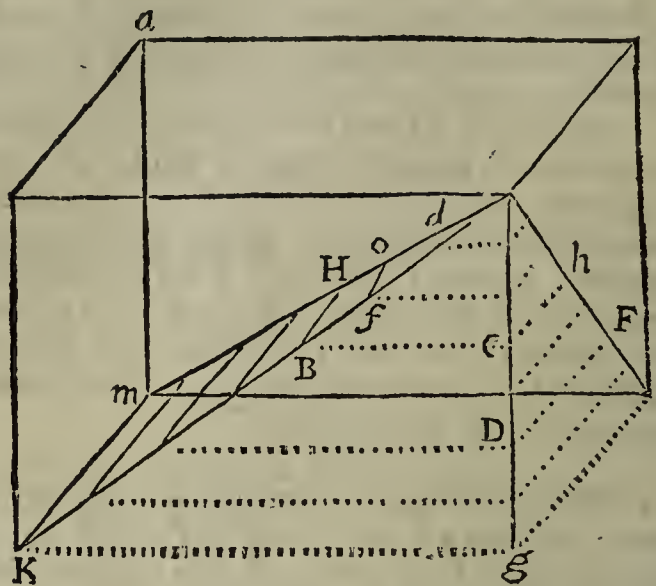
#### CASE II.

If  $d$ , the Side of a Square, which is the Difference of the Squares required, were given; make as  $d : b :: c : f$  a fourth Proportional; and, by the former Problem, find 2 Lines reciprocally proportional to  $b$  and  $c$ ; which suppose to be  $g$  and  $d + g$ , whose Difference is  $d$ : Then erect  $f$  at Right Angles, and on  $d + g$ , describe a Semi-Circle: After which drawing  $a$  and  $e$ , they shall be the Sides of the Squares required.



#### Of the Proportion of Solids.

Every Parallelopiped, as  $a g$ , is to a Pyramid,  $g k m n b$  of the same Base and Height, as 3 to 1.



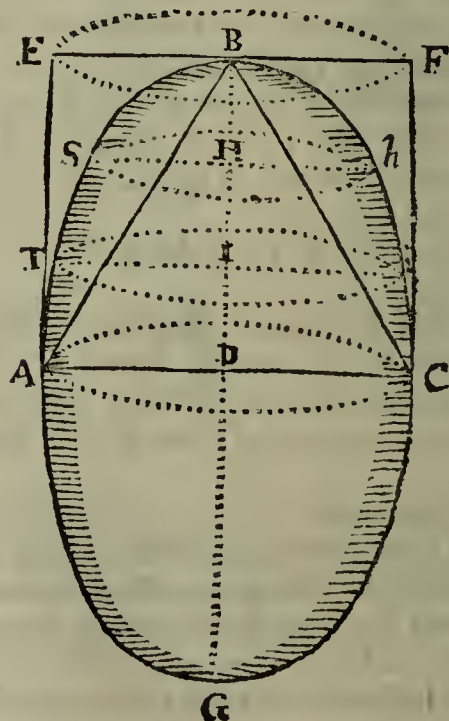
For if you suppose the Altitude  $bg$ , to be divided into any Number of equal Parts, by Plains parallel to the Base; then because of the Pyramids  $b n g k$ ,  $m b$ ,  $b F D B H b$ , &c. being similar, the Bases  $m n g k$  and  $H B D F$ , will be in a duplicate Ratio of their Altitudes  $bg$ ,  $D b$ . That is, These Bases diminish towards the Vertex in the Proportion of the Squares of Numbers in Arithmetical Progression.

But it was proved above in Numb. 7. of *Arithmetical Progression*, That a Rank of such Quantities are Subtriple to as many, equal to the greatest; *i. e.* to such as compose, or are the Elements of the Parallelopiped: Wherefore the Parallelopiped to the Pyramid, is as 3 to 1, or the former is triple of the latter.

And this must hold in all Prisms of what Figure soever, in reference to a Pyramid of the same Base with them.

And so also in the Proportion of Cones to Cylinders; for a Cone being composed of Circles whose Peripheries decrease Arithmetically, the Planes of those Circles must be a Rank of *Secundans*, (for they are as the Squares of their Radius) and consequently the whole Rank, or the Cone, will be Subtriple of the Cylinder, which is a Rank of as many Terms equal to the greatest.

A Cylinder, Spheroid, and Cone, of the same Base and Height, are as 3, 2, and 1.



Let the Semispheroid  $A T S B h i c$  be divided into 3 equal Parts, as in the Figure. Then the Ellipsis,



*Ellipsis*, as well as in the Circle) the  $\square A D : \square S H :: \square G D B : \square G H B$ ; that is, as  $3 \times 3$  (or 9) is to  $5 \times 1$  (or 5). Also  $A D : \square T I :: 9 : 8$ . And thus it will be, if you make never so many new Bisections; that is, you'll find the Squares of the Ordinates, and consequently the Circles made on them do decrease by a Progreſſion of odd Numbers. But a Series of ſuch a Progreſſion is to as many equal to greateſt as 3 to 2 (by Coroll. 5. of *Progreſſion Geometrical*) wherefore the *Cylinder* to the *Spheroid* is as 3 to 2, and being to the *Cone* as 3 to 1. The *Cylinder*, *Spheroid* and *Cone*, are as 3, 2, and 1. *Q. E. D.*

**PROPORTIONAL**, a Quantity either Numeral or Lineary, which bears the ſame Ratio or Relation to a Third, as the Firſt does to the Second.

**PROPORTIONAL Compaſſes**, an Inſtrument for the ready drawing of Lines, and Figures in any given Ratio to other Figures.

**PROPORTIONAL Scales**, ſometimes alſo called *Logarithmetical*; are only the Artificial Numbers of Logarithms placed on Lines, for the eaſe and advantage of Multiplying, Dividing, Extracting Roots, &c. by means of *Compaſſes*, or by *Sliding Rules*; and they are only ſo many *Lines* of Numbers, as they are called by Mr. Gunter. (See *Gunter's Line*.) But made *Single*, *Double*, *Triple*, or *Quadruple*; beyond which they ſeldom go.

**PROPORTIONAL Spiral Lines**. See *Spiral Lines*.

**PROPOSITION** [in *Mathematicks*] is ſome Truth advanced and ſhewn to be ſuch by Demonſtration; or it is ſome Operation propos'd, and the Solution ſhewn.

If the Propoſitions are deduced from ſeveral theoretical Definitions compared together; as this, a Parallelogram is double of a Triangle, ſtanding on the ſame Baſe, and of the ſame Altitude; it is call'd a *Theorem*.

If from a *Praxis* or Series of Operations it is called a *Problem*, as to find a third Proportional to two given Quantities.

**PROPRIETATE Probanda**, is a Writ that lies for him that would prove a *Property* before the Sheriff: For where a *Property* is alledged, a *Replegiare* lieth not.

**PROPRIETOR** [in *Law*] is in ſtrictneſs ſuch an one as has or poſſeſſes the Property or Propriety of any thing.

**PROPTOSIS**, [*πρόπτωσις* of *πρὸς* and *πίπτω*, Gr. to fall] is the Falling-down of ſome Part; as of the Eye, the Cawl, &c.

**PRO Rata**. See *Oneranda pro rata portionis*.

**PRORÆ Os** [in *Anatomy*] a Bone of the *Cranium*, call'd alſo *Os Occipitis*. L.

**PROROGUE**, ſignifies to prolong, or put off to another Day. The Difference between a *Prorogation* and an *Adjournment*, or Continuance of the Parliament, is, That by the *Prorogation* in open Court, there is a Seſſion; and then ſuch Bills as paſſed in either Houſe, or both Houſes, and had not the Aſſent to them, muſt at the next Aſſembly begin again: For every Seſſion of Parliament is in *Law* a ſeveral Parliament; but if it be but *Adjourned* or *Continued*, then there is no Seſſion, and conſequently all Things continued in the ſame State they were in before the *Adjournment*.

**PROSECUTOR**, in *Law*, is he that follows a Cauſe in another's Name. See *Promoters*.

**PROSODIA**, is that Part of Grammar which teaches the Quantity of Syllables, diſtinguiſhing into Long and Short, &c.

**PROSOPOPOEIA**, [*προσωποποιεῖα*, Gr.] is a violent Rhetorical Figure, wherein the Speaker addreſſes himſelf to inanimate Things as if they were living, and makes them ſpeak as if they had Souls.

**PROSPHYSIS**, [*πρόσφυσις*, Gr.] is a Coalition, or growing together, as when two Fingers are connected to each other.

**PROSTAPHÆRESIS**, [*προσάφαιρεσις*, Gr.] in Astronomy, is the ſame with the Equation of the Orbit, or ſimply the *Equation*; and is the Difference between the *True* and *Mean Motion* of a Planet. The Angle alſo made by the Lines of the Planets *Mean* and *True Motion*, is called the *Proſtaphereſis*.

**PROSTATÆ**, *Adſtantes*, or *Corpora Glanduloſa*, are two Glandules placed near the Paſſage of the Seed; which (as may be gueſs'd) lubricate the common Paſſage of the Seed and Urine, and afford a kind of a Vehicle to the Seminal Matter, and are ſaid to provoke the Titillation in Coition: Their Moiſture being conveyed by certain little Tubes, which terminate in the Paſſage near where the Seed is ejection, and is emitted at the ſame time with it. The Learned *Bartholine* has obſerved ſome ſuch thing in Women.

**PROSTASIS**, a Part of Surgery, which fills up what is wanting; as we ſee in hollow and fiſtulous Ulcers filled up with Fleſh by Surgery. *Blanch*.

**PROSTHESIS**, [*πρόσθεσις*, Gr.] in Grammar, is in the General a Metaplaſm, and in particular an Addition of ſome Letter or Letters to the Beginning of a Word, as *Gnavus pro navus*. This is alſo called *Appoſition*.

**PROSTOMIA**, [*πρόσθμια*, Gr.] the Red-tinted Part of the Lips. *Blanchard*.

**PROTECTION**, in *Law*, hath a general and a ſpecial Signification: In the general, it is uſed for that Benefit and Safety which every Subject, Deniſon or Alien, eſpecially ſecured, hath by the King's Laws. *Protection*, in the Special Signification, is uſed for an Exemption or Immunity given by the King to a Perſon againſt Suits in *Law*, or other Vexations, upon Reasonable Cauſes moving him thereto. Of this *Fitz-Herbert* maketh two Kinds; the Firſt he calls a *Protection*, *cum clauſula volumus*, whereof he mentions Four Particulars: 1. A *Protection quia profecturus*, for him that is to paſs over Sea in the King's Service. 2. A *Protection quia moraturus*, for him that is Abroad in the King's Service upon the Sea, or in the Marches. 3. A *Protection* for the King's Debtor; that he be not ſued or attached till the King be paid his Debt: This the *Civilians* call *Moratorium*. 4. A *Protection* in the King's Service beyond Sea, or in the Marches of Scotland.

The Second Form of *Protection* is *cum clauſula nolumus*, which is granted moſt commonly to a Spiritual Company for their Immunity, from taking their Cattle by the King's Miniſters: But it may be granted alſo to one Man Spiritual or Temporal.

**PROTEST**, in *Law*, hath two divers Applications; One is by way of Caution, to call witneſs, (as it were) or openly to affirm, That he doth  
either



either not at all, or but conditionally yield his Consent to any Act, or unto the Proceeding of any Judge in a Court wherein his Jurisdiction is doubtful, or to answer upon his Oath further than by Law he is bound. The other is by way of Complaint, to *Protest* a Man's Bill. For Example: If I give Money to a Merchant in *France*, taking his Bill of Exchange to be repaid in *England* by one whom he assigneth; If at my coming, I find not my self satisfied, but either delay'd or deny'd, then I go to the *Exchange*, or other open Concourfe of *Merchants*, and *Protest*, That I am not paid: And thereupon, if he hath any Goods remaining in any Man's Hands within the Realm, the *Law of Merchants* is, That I be paid out of them to my full Satisfaction.

PROTESTATION, in Law, is a Defence of Safeguard to the Party which maketh it, from being concluded by the Act he is about to do, that Issue cannot be joined by it.

PROTHESIS, *Prosthesis*, [with *Chirurgeons*] is the filling up of what was before wanting, as the filling up of fistulous Ulcers with new Flesh.

PROTHYRUM, [*πρόθυρον*, Gr.] a Porch at the outward Door of a House or Portal.

PROTHYRIS, *Prothyride*, [in *Architecture*] so *Vignola* calls a particular Key of an Arch, an Instance of which may be had in the *Ionick* Order, which consists of a Roll of Water-Leaves between two Reglets and two Fillets crown'd with a *Dorick Cymatium*; the Figure being much like that of a *Modillion*.

PROTHYRIS, [in the antient *Architecture*] is sometimes used for the Quoin or Corner of a Wall; and at other times for a cross Beam or overthwart Rafter.

PROTOPATHIA, is a Primary Disease not caused by another.

PROTRACTING-Pin, is a fine Needle fastened in a Piece of Wood, Ivory, &c. used to prick off any Degrees and Minutes from the *Protractor*.

PROTRACTOR, is an Instrument used in *Surveying*: It is commonly made of a well-polish'd thin Piece of Brass, and consisteth of a *Semi-circle* divided into Degrees, and a *Parallelogram* with Scales upon it, and may be of any Bigness desir'd. But this Instrument is so well known, that there needs no farther Description.

Its Use is chiefly, To lay down an Angle of any assigned Quantity of Degrees: Or, an Angle being *Protracted*, to find the Quantity of Degrees it contains readily; which is of great Use in Plotting, and making of Draughts, &c.

PROTRACTOR *Improv'd*, a Machine like the former; but furnished with a little more *Apparatus* whereby an Angle may be set off to a Minute, which cannot be done by the other.

PROTRACTOR [with *Surgeons*] an Instrument for drawing any foreign or disagreeable Bodies out of a Wound or Ulcer in like manner as the Forceps.

PROTUBERANCE [in *Anatomy*] an Eminence or Tumour that Projects or puts out beyond the rest.

PROVER [in *Law*] an Approver or a Person who confessing Felony, Appeals or Accuses another of the same; so called because he is obliged to prove what he alledges in his Appeal.

PROVINCE, was used among the *Romans* for a Country without the Limits of *Italy*, and gained

to their Subjection by the Sword. But with us the Word is most commonly used for the Circuit of an Archbishop's Jurisdiction; and in some of our Statutes 'tis used for a County.

PROVISION, in the Canon Law, is used for the providing of a Bishop or any other Person, an Ecclesiastical Living, by the Pope, before the Incumbent be dead. 'Tis called also *Gratia expectativa*, and *Mandatum de Providendo*.

PROVISIONS. The Acts to restrain the exorbitant abuse of Arbitrary Power, made in the Parliament at *Oxford*, 1258, were called *Provisions*; because they provided against the King's Absolute Will and Pleasure.

PROVISO, is a Condition inserted into any Deed, upon the Observance whereof the Validity of the Deed depends; but sometimes it is only a Covenant. It hath also another Signification in Matters Judicial, as if the Plaintiff or Demandant desist in prosecuting an Action, by bringing it to a Trial; the Defendant or Tenant may take out a *Venire facias* to the Sheriff, which hath in it these Words, *Proviso quod*, &c. to this End, That if the Plaintiff take out any Writ to that Purpose, the Sheriff shall summon but one Jury upon them both: In which Case, we will call it going to Trial by *Proviso*.

PROVISO, in the Sea-Phrase, for a Ship to *Moor a Proviso*, is for her to have one Anchor out, and also a Hawser ashore, and so she is moored with her Head to the Shore with two Cables.

PROVISOR, is he that sues to *Rome* for a *Provision*; which see.

PROVOST *Marshal*, of an Army, is one appointed to secure Deserters, and all other Criminals: He is to go often abroad round the Army, to hinder the Soldiers from Pillaging: 'Tis part of his Office to indite Offenders, and to execute the Sentence pass'd upon them. He likewise regulates the Weights and Measures, and the Price of all Provisions, &c. in the Army. There is also a

PROVOST *Marshal* in the Royal Navy, who hath charge of the Prisoners taken at Sea. 13 Car. II. c. 9.

PROXIMITY [*Proximitas* L.] nearness, either in respect of Place, or Blood, or Alliance.

PROXY, [*Procurator*, L.] a Deputy or Person who officiates in the room of another.

PROW of a Ship, is that Part of her *Fore-castle* which is *Aloft*, and not in in the *Hold*; and is properly that which is between the *Chase* and the *Loof*.

PRUDENCE, is by the Writers of Ethicks defined to be a Habit of the Mind, by which a Man judges and determines truly how he should act and proceed, what he should do or avoid, in all things relating to his Temporal or Eternal Advantage, so as to render himself happy here and hereafter.

PRUINA [in *Physiology*] hoar Frost, a Concretion of the Dew, made by the Violence of the external Cold.

PRUNELLA [in *Physick*] a Dryness of the Tongue and Throat, which happens in continual Fevers, especially acute ones, attended with a heat and redness of the Throat, and a Scurf, covering the Tongue, which is sometimes whitish and sometimes blackish.

PRUNELLÆ Sal. See *Sal Prunellæ*.

PRUNIFEROUS Trees or Shrubs, are such whose



whose Fruit is pretty large and soft, with a Stone in the middle; in this kind the Flower adheres to the Bottom of the Base of the Fruit.

**PRURITUS** [in *Medicine*] a Sensation of the Skin, commonly called Itching; which is suppos'd to proceed from an Obstruction in the Extremities of the capillary Veins; so that they cannot take up the redundant Blood of the Members to convey it back again to the Heart; whence as there is a fresh Stock of Blood continually sent into the Part by the incessant Pulsation of the Heart, the Fibres become stretched or distended preternaturally, and hence proceeds the uneasy titillating Sense of Itching.

**PRYAN Tin**, is a sort of Tin that is found mix'd with a Gravelly Earth, sometimes White, but usually Red; 'tis not half so good as the other which is made out of Stone.

**PSAMMISMUS**, [*ψαμμισμός*, Gr.] a Bath of dry and warm Sand, wherewith the Feet of Men in the Dropsy are dried. *Blanchard*.

**PSEUDODIPTERON**, [of *ψεῦδος*, *false*, and *διπτερος*, of *δις*, *twice*, and *πτερον*, Gr. *a Wing*] is an ancient Form of a Temple, compassed about with but one Row of Pillars, and which Row from the Wall, is at the Distance usually of two Rows of Pillars.

**PSEUDOSTELLA**, [of *ψεῦδος* and *Stella*, L.] in Astronomy, signifies any kind of Comet or Phænomenon newly appearing in the Heavens like a Star.

**PSOAS Magnus**, or *Lumbalis*, [of *ψῶας*, Gr. *the Loins*] is a Muscle of the Loins, which proceeds from all the Vertebres of the Loins and their transverse Processes internally and laterally, within the Cavity of the *Abdomen*; from thence descending over the superior Part of the *Os Sacrum* and Spine of the *Ilium*, where it's joined with the fleshy Fibres of the *Iliacus Internus*, with which it is inseparably united to their partly Fleshy and partly Tendinous Insertions in the inferior Part of the lesser *Trochanter* of the Thigh-Bone: It's Use is, together with the *Iliacus Internus*, to move the Thigh forwards.

**PSOAS Parvus**, is a Muscle of the Thigh, which arises fleshy from the superior Part of the first *Vertebra* of the Loins, internally and laterally within the *Abdomen*, immediately below the Cavity of the *Diaphragm*, whence descending obliquely inwards towards the *Pelvis Abdominis* (where it ceases to be Fleshy) in a manner embracing the *Psoas Magnus*, and is inserted with a thin, broad, strong Tendon, to that Part of the *Os Pubis*, where it is join'd to the *Os Ilium*: This Muscle, with its Partner acting, assists the *Recti Abdominis* in drawing the *Ossa Pubis* upwards, as in raising our selves from a decumbent Posture. Thus Rope-Dancers hang by their Hands, and raise the inferior Parts of their Bodies, to take hold of a Rope with their Feet. Tho' their proper Action is to bend the Loins, yet their Tendons embracing the *Psoas Magnus* and *Iliacus Internus*, (which we have frequently observed to extend over the inferior Parts) not unlike the *Fascia Tendinosa Cubiti* and *Lata* of the Thigh, do also Corroborate them in their Action. *Cowper*.

**PSOROPHTHALMY**; [of *ψώρα*, *a Scab*, and *ὀφθαλμός*, Gr. *an Eye*] an *Ophthalmy*, or Inflammation of the Eyes with itching. *Blanchard*.

**PSYCHROMETER**, [*ψυχρόμετρον* of *ψυχρός*, and *μέτρον*, Gr. *measure*] an Instrument for measuring the Degree of Moisture or Humidity of the Air, the same as *Hygrometer*.

**PSYCHTICA**, [of *ψυχρός*, Gr. *Cold*] are cooling Medicines against the Scab. *Blanchard*.

**PTARMICA**, [*πταρμικά* of *πταρνόμα*, Gr. *to Sneeze*] or *Sternutatoria*, are those things which being endowed with a more piercing Acrimony than the Errhinaceous Medicines, do so extremely irritate and shrivel up the Membranes of the Brain, that it sends forth the pituitous Humour at the Nostrils, in an extraordinary Measure, and so cause Sneezing. *Blanchard*.

**PTERYGOIDES**, [*πτερυγοειδής* of *πτερυξ*, *a Wing*, and *εἶδος*, Gr. *Form*] are two Apophyses of the *Os Sphenoides* so call'd from their resemblance to the Wings of a Bat.

**PTERIGOPALATINUS**, [of *πτερον*, *a Wing*, and *Palatum*, *the Palate*] or *Sphterigopalatinus*, is a Muscle of the *Gargareon*, whose former Appellation intimates its Progress and Insertion; the latter its Origin also. This arises from the Process of the *Os Sphenoides*, and descends according to the Length of the Interstice made by the internal *Ala* of the *Os Sphenoides*, and *Musculus Pterigoidæus Internus* of the lower Jaw; and becoming Tendinous, marches over the *Processus Pterigoides*, and is inserted to the Fore-part of the *Gargareon*. The Tendon of this passes over the Pterigoidal Process, which, like a Pulley, gives it a different Power from that of the *Sphænopalatinus*, tho' they have both their Origin from the same Place. Wherefore, contrary to that, This draws the *Gargareon* downwards; which Contrivance in Nature is no less remarkable, than any of those where the like Artifice of a *Trochlea* is made use of.

**PTERIGOPHARYNGÆUS**, [of *πτερον* and *φάρυγξ*, Gr.] is a Muscle which arises thin and fleshy from both the Pterigoidal Processes of the *Os Cuneiforme*; also from the Root of the Tongue, and Extremities of the *Os Hyoides*; from these Places its fleshy Fibres run in a Semi-circular manner, embracing the superior and back Part of the glandulous Membrane of the *Fauces*, where they meet in a middle Line. When this Muscle acts, it brings the middle or back Part of the *Fauces* towards a Plain, by which means the *Tonsillæ*, together with the rest of the Glandules, are compress'd in the Evacuation of their *Mucus*, to join with the Aliment in its Descent into the *Stomach* in *Deglutition*; and at other times to promote *Secreation*; in which this Muscle is the chief Instrument: That the *Tonsillæ* approach towards each other, is observable, when we inspect these Parts in living Persons.

**PTERIGOSTAPHYLINUS**, [of *πτερον* and *σταφυλή*, *a Grape*] *Externus*, is a Muscle which moves the *Uvula*, arising from a small Protuberance upon the under Side of the Body of the *Os Sphenoides*, and goes directly to be inserted into the hinder Part of the *Uvula*.

**PTERIGOSTAPHYLINUS Internus**, is a Muscle which moves the *Uvula*, arising from a small Protuberance of the *Os Sphenoides*, and growing into a small Tendon, which passes over a small round Process like a Hook, of the *Processus Pterigoidæus*; from thence reverting, it's inserted into the Fore-part of the *Uvula*.

PTERY-



**PTERYGIUM**, [ $\pi\tau\epsilon\rho\gamma\iota\omicron\nu$ , Gr. *a little Wing*] is the Wing or round-rising of the Nose or Eye, or the Process of the Bone *Sphænoides*, which is like a Wing. Also a membranous Excrescence above the horny Tunic of the Eye, call'd *Unguis* and *Ungula*, growing for the most part from the inner Corner, towards the Apple of the Eye, and often obscuring it. *Blanchard*.

**PTERYGOIDÆUS**, [of  $\pi\tau\epsilon\rho\gamma\iota\omicron\nu$  and  $\alpha\iota\delta\epsilon\upsilon\varsigma$ , Gr. *Form*] *Internus* and *Externus*, are two Muscles arising from the *Processus Pterygoides*, or *Aliformis* of the *Os Sphænoides*. Their Use is to move the Jaw from Side to Side.

**PTERYSTAPHYLINI**, [of  $\pi\tau\epsilon\rho\gamma\iota\omicron\nu$  and  $\sigma\tau\alpha\phi\upsilon\lambda\eta$ , Gr.] are Muscles of the *Uvula* or *Gargareon*, and were so named by *Riolanus*; but the Accurate Dr. *Croon* changed their Names into *Sphænopalatinus* and *Pterygopalatinus*, or *Sphænopterygopalatinus*. (See those Words.) Their Use is to give various Motions to the *Uvula*.

**PTISANA**, [ $\pi\tau\iota\sigma\acute{\alpha}\nu\eta$ , Gr.] *Ptisana*, is a Decoction of Pearl-Barley, Liquorish, Raisins, &c. being a cooling pleasant Drink for one in a Fever, and much used by the *French*.

**PTOLEMAICK System** of the Heavens, was that invented by *Ptolemy*; in which he supposes the Earth immovable any way in the Centre of the Universe, round about which the Moon first moves in a Circle; next her *Mercury*, then *Venus*; above whom moves the *Sun* then *Mars*; above him *Jupiter*, and last of all *Saturn*, all in the Zodiac from West to East. Above *Saturn* he places the Sphere of the fix'd Stars, which he supposes to move slowly also from East to West, on the Poles of the Ecliptick, while the fix'd Stars themselves, and all the Planets, move from East to West, on the Poles of the Equator, in the space of a Natural Day, or 24 Hours. This Vulgar System of Astronomy, in which I omit to mention the *Epicycles* and *Deferents*, &c. with which they endeavoured to solve the *Phænomena* which did almost all of them contradict this Scheme was plainly overturned and refuted as soon as ever the use of the Telescope acquainted us with the *Phases* of *Venus* and *Mercury*; for from thence it was apparent, that their Orbits included the Sun, and therefore by degrees it came to be quite disused, and consequently I shall say no more of it.

**PTYALISM**, [ $\pi\tau\upsilon\acute{\alpha}\lambda\iota\sigma\mu\omicron\varsigma$ , Gr.] a Discharge of *Saliva* through the Glands of the Mouth, whether it amount to an absolute Salivation or not.

**PTYLOSIS**, is a Disease when the Brims of the Eye-lids being grown thick, the Hairs of the Eye-brows fall off. *Blanchard*.

**PUBIS OS**. See *Pectinis Os*.

**PUDDINGS**, in a Ship, are Ropes nailed to the Arms of the Main and Fore-Yards, near the Ends, and then at 3 or 4 due distances inwards one from another, in order to keep the Robbins from galling or wearing asunder upon the Yards, when the Top-sail-Sheets are haled home.

They call also those Ropes which are wound about the Rings of Anchors to save the Clinch of the Cable from being galled with the Iron, by this Name. So that when the Ring is so served, 'tis called the Pudding of the Anchor.

**PUDICÆ Plantæ**, the same with sensitive Plants; which see.

**PUGILLUS**, is an handful of any Herb. O-

thers interpret it, as much as may be taken up with the Thumb and two Fingers.

**PUISNE**, or *Puny*; the Lawyers term for Younger.

**PULLET**, in a Ship, is a little Room within her Hold, in which the Pigs of Lead, or such like weighty things are put, that the Ship may be well ballasted in a little Room.

**PULLEY**, is a compounded Mechanick Power, consisting of one or more *Shivers* or *Rundles* with proper Blocks, &c. to raise up any Weight, &c. and this Instrument so fitted is called *Trochlea* or the *Pulley*; and at Sea with Ropes, &c. fitted so to it, it is called a *Tackle*.

In every Pulley, from the Position and Number of the Shivers, you may know how much the Weight *W* is diminished, by making the *Vis Motrix*, or Power, to be to the Weight: as 1 to the Number of the parts of the Rope going up and down.

Only this you must observe, that it is the lower Pulleys, or Blocks with Shivers, that give any Force to the Motion; for if a Weight hang on any upper Pulley or Shiver, it will require a Power to sustain it that shall be fully equal to the Weight.

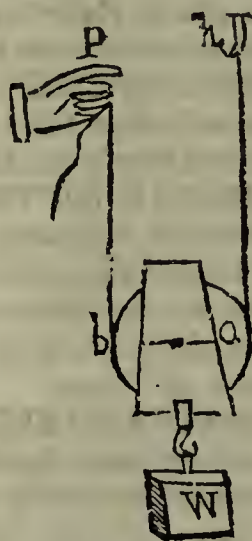
Thus if a Weight hang as in the Position *a W*, it would certainly fall, if a Force or Power equal to it did not hold the Rope *b d*.

And all upper *Shivers* being every where of the same Nature, none of them can conduce any thing towards easing the Power or lightening the Weight; but they only serve for the Convenience of the Motion.

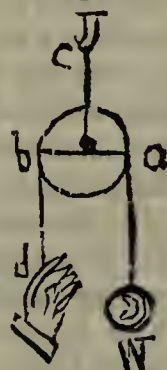
But if you suppose the Weight *W* (as in *Fig. 1.*) to be sustained by the Hook *b*, above the Block *a b*, then 'tis plain that the Hook *b* will sustain just half the Weight, and therefore the Power at *P* need be but equal to half the Weight *W*; for 'tis all one as if the Weight were hung to the middle of a Balance or *Libra a b*, whose equal Arms were upheld by two several Strings, as *b a* and *P b*.

'Tis also apparent in *Fig. 1.* That in order to raise the Weight *W*, the Height of one Foot, each part of the Rope, *viz. b a* and *P p*; (accounting downwards from the Hook *b*) must be made a Foot shorter, *i. e.* the Power must move two Feet, in order to raise the Weight but one: Wherefore in this Engine, the way of the Power is double to that of the Weight; and therefore their Celerities will also be in the same Ratio; wherefore if the Power be to the Weight as 1: to 2, its *Moment* will be equal to that of the Weight, and so will sustain the Weight.

*Fig. 1.*

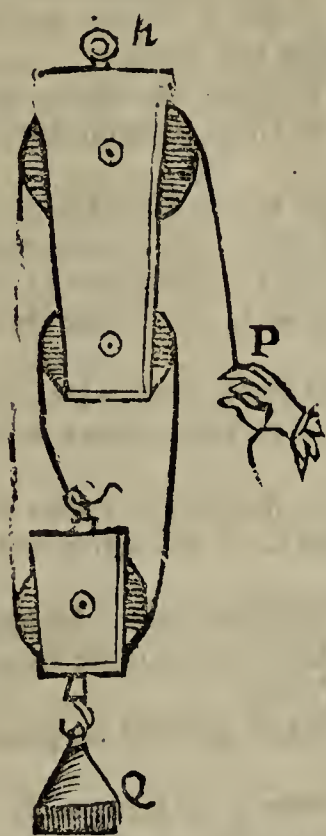


*Fig. 2.*

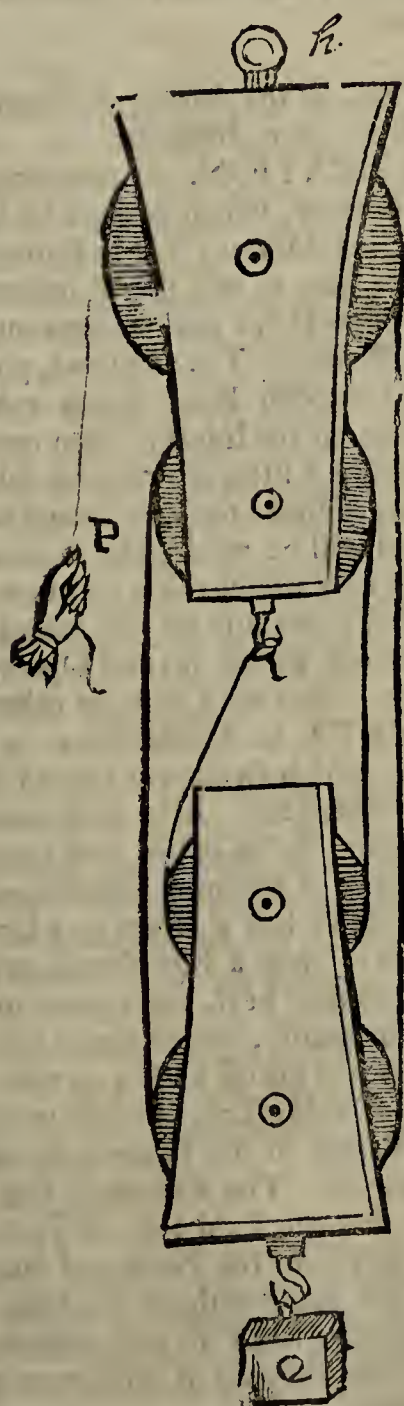




If the Weight be sustained by 3 turns of the Rope, and be made to ascend one Foot (as in Fig.

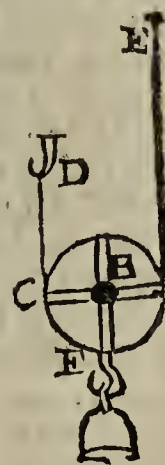


3.) then each Part, or Turn, or Fall of the Rope must be shortened 1 Foot (reckoning as before) from the Hook at h and this cannot be done unless the Power in P move three Feet: Here therefore the way of the Power is triple to that of the Weight, as is also its Celerity; wherefore if the Power be to the Weight as 1 to 3, or one third of it, it will sustain the Weight.



And so on in the 4th Fig. the Power P must be one fourth of the Weight, &c.

The Pulley is a Wheel not only turning round its Axis, but made so, that at the same time 'tis drawn up by a Rope or Cord that goes round it: This may be considered as a perpetual *Homodromous* Lever or *Vestis*; for the Cord which is put over the Wheel A F C being fastned at one End at D, and the other End at E being drawn or held by some Power, so that the Weight suspended from the middle of the Wheel A F C, be kept in *Equilibrio*; 'tis then plain, that the moving Force is apply'd to the lower Pulley or Shiver in A; one of the Extremes of the Lever A C, the other Extreme C rising on the fix'd Rope or Chord D C as on an *Hypomochlion*. 'Tis plain also, that the Weight F is suspended from the middle Point B, and consequently as A C, the distance of the moving Force from the *Hypomochlion*, to B C, the distance of the Point of Suspension of the Weight from the same (that is, as 2 to 1) :: so is reciprocally (from the Nature of the Lever) the Weight F to the Force sustaining it in E; and consequently one under-Pulley takes off always half the Weight, or raises double the Weight with the same Power or Force.



But if the Pulley be fix'd above only, it affords no help towards lifting up the Weight more easily; for here the moving Force in E must be equal to the Weight in W, because the *Hypomochlion* in this Case is in the middle at B; and consequently the Weight and Power equidistant from it, as in the Balance.

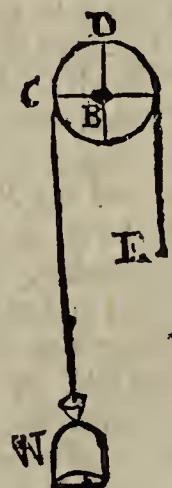
The upper Pulleys or Shivers then are of no other use but to facilitate the Motion of this Rope by their Volubility and apt Position.

So that to estimate the Power of the Combination of never so many Shivers or Pulleys put together, you need only double the Number of the lower Shivers, or of the Cords which pass over them without considering the upper ones, and they will give you the Multiple of the Weight to be raised this way; in comparison of what could be raised without any such help by the same Power.

So the Force of 50lb. in a Pulley with two lower Shivers will raise four times as much, viz. 200lb.

If the Force of 50lb. and the Weight 200lb. be both given, and the Number of Shivers be required, 'tis plain you must divide 200 by 50; that is, the Weight by the Power, and the Quotient will be 4, the Number of Ropes, and the half of that is the Number of lower Shivers.

If the Weight, suppose 1000 lb. be given, and the Number of Pulleys or Ropes, suppose 4; then divide the Weight by the Pulleys, and the Quotient is the Power or Force required; viz. 250lb. And this Method of proceeding will give you the *Desiderata* in any Combination of Pulleys, and in any Conjugation of many Combinations.





**PUBERTY** [*Pubertas*, L.] a Term in the Civil Law, implying a natural Majority; or the Age wherein a Person is allowed to contract Marriage, *i. e.* at 14 Years in Boys, and 12 in Maids, and full Puberty is at 18.

**PUBES** [in *Anatomy*] the external Parts of the *Pudenda*, or Parts of Generation in both Sexes.

**PULMONARIA Arteria**, or *Vena Arteriosa*, is a Vessel in the Breast, arising immediately out of the Right Ventricle of the Heart; its Mouth is not so large as that of the *Cava*: It has three Valves, called *Sigmoidales* or *Semilunares*. Its Use is to carry the Blood from the right Ventricle of the Heart to the Lungs, and its Coat is double, like that of the Arteries.

**PULMONARIA Vena**, or *Arteria Venosa*, is a Vessel of the Heart, which discharges it self thro' the left Auricle into the Ventricle of the same side; for after it has accompanied the Wind-pipe and *Arteria Pulmonaris* in all their Branchings in the Lungs; and by its small Twigs has received the Blood out of the Artery, all these Twigs are united first into two Trunks (*viz.* the Right and Left) afterwards into one, which opens into the Left Ventricle of the Heart. This *Vein* hath no Valve in it, except that at its opening into the Left Ventricle, where at its Orifice are placed two Membranous Valves, called *Mitralis* from their Form resembling, when joined, something of a Mitre. These are very strong and firm, to sustain the violent Motion of the Blood, and to hinder it from returning back again into this Vein, and to direct its Course to the *Aorta*, whose Orifice opens in the *Systole* of the Ventricle.

**PULMONARY-Vessels**, are those which carry the Blood from the Heart to the Lungs, and back again, being two in Number, *viz.* the *Pulmonary Vein*; and the *Pulmonary Artery*; which see.

**PULPA**, is the fleshy Part of Fruits, Roots, or other Bodies, which is extracted by Infusion or Boiling, and passing through a Sieve; as the Pulp of *Tamarinds*, *Althea*, *Dates*, &c.

**PULSE**, by Mathematical Naturalists, is the Term used for that Stroke with which any Medium is affected by the Motion of *Light*, *Sound*, &c. through it.

And the Admirable Sir *Isaac Newton* demonstrates, *lib. 2. prop. 48. Princip.* That the Velocities of the Pulses, in an Elastick Fluid Medium (whose Elasticity is proportionable to its Density) are in a Ratio, compounded of half the Ratio of the Elastick Force directly, and half the Ratio of the Density inversely. So that in a Medium, whose Elasticity is equal to its Density, all Pulses will be equally swift.

**PULSUS**, the Pulse, is the immediate Index of the Heart, by the Mediation whereof the Blood is diffused through the whole Body, and is differently affected thereby, according to the different Influx of the Animal Spirits; the Motion whereof is chiefly to be attributed to the circular and direct Fibres. Others affirm it to be the Dilatation and Contraction of the Heart and Blood. A Pulse is either Natural or Preternatural; of the former we have spoken already; the latter is such as is different, according to the different Circumstances of the Fibres and Animal Spirits; to wit, *strong*, *weak*, *swift*, *slow*, *equal*, *unequal*, *intermittent*, &c.

**PULSES**, according to Dr. *Abercromby*, are either,

*Pulse Unequal*, is either in respect of Time or Strength; that is, either it strikes quicker and slower, or else stronger and weaker.

*Pulse Interrupted*, is when the Strokes are much smaller than usual, or their Interval much greater.

*Pulse Intense* is that whose Stroke is very hard, (the Parts being as it were upon a bent) or else this Strength is made up with the Multiplicity and Frequency of less Mications, as in the Heights of Fevers.

*Pulse Remiss*, is that whose Strokes are less quick, or less strong, and in Sickness shews more Danger than the other.

*Pulse Superficial*, is that which shews an exact Temperament of Body, as also a free and merry Temper of Mind.

*Pulse Deep*, shews a Disposition of Melancholy, Asthmas, Lethargy, &c. and is more frequent in the Aged than the Young.

*Pulse Leaping*, is said to portend no great Danger.

*Pulse Trembling*, shews great Extremity.

*Pulse Wandring*, is that which is sometimes felt in one place, and sometimes in another, and sometimes no where, and is never but a few Minutes before Death.

**PULSION**, is the driving or impelling of any thing forward. See *Attraction*.

**PULVERIZATION**, in reducing any Body into a fine Powder, which is done by beating *Friable* Bodies in a Mortar; but to Pulverize *Malleable* ones, or such as will spread under the Hammer, some other Helps and Artifices must be made use of. To *Pulverize* Tin and Lead, proceed thus: Get a round wooden Box, which rub well with Chalk all over on the Inside; then melt the Metal, and pouring a little of it nimbly into the Box, shut the Lid, and shake the Box strongly and quick, and the Metal will be reduced by it into a Powder. And this is a very useful thing to know, tho' it be plain and easy; because by this means these Metals are rendered fit for several Operations, and will easily be mixed with Salts or other Things.

**PULVINATA**, in Architecture, is the Term for a *Freeze*, which swells out like a Pillow.

**PULVIS Fulminans**. Mix well together three parts of common Saltpetre, two parts of Salt of Tartar, and one of common Brimstone, all finely powdered. Take half a Dram or a Dram of this Mixture, put it upon a Fire-shovel over a gentle Fire, so that it may heat, and appear to melt and change Colour gently, and in about half a quarter of an Hour it will go off with a terrible Noise, as great as that of a Musket, and yet without Danger to any Person in the Room; for its Force is chiefly downwards. The Reason of this Effect appears to be, that the fix'd Salt of Tartar doth so lock up the Spirits of the Nitre and Sulphur, that they cannot get loose without breaking their Prisons, which when the Fire hath assisted and enabled them to do, they do it with very great Violence and Noise.

**PUMP Brake**, at Sea, is the Handle of the Pump, as,



**PUMP Can**, is the Bucket whereby they pour Water into the Pump to fetch it, and make it work when they intend to use it. And

**PUMP Vale**, is the Trough by which the Water runs from the Pump along the Ship-sides, that it may go out at the *Scoper-Holes*.

**PUMPS**, in a Ship are of several sorts, as the *Chain-Pumps* which are used in great Ships; and these go with more ease than others, yield more Water, and are easily mended. *Bare-Pumps*, are small ones made of a Cane or a piece of Wood bored thro', and are used to pump Beer or Water out of the Casks. *Bur-Pumps*, are used by the *Dutch*, who have them by their Ships sides. In these there is a long Staff with a Bur at the end like a Gunner's Sponge, to Pump up the *Bildgewater*: These are also called *Bildge-Pumps*.

**PUNCHINS**, in Architecture, are short pieces of Timber, placed to support some considerable Weight: They commonly stand upright between the Posts, and are shorter and flighter than either the *Principal Posts* or *Prick Posts*. Those that stand on each side of a Door are called *Door Punchins*.

**PUNCTATED Hyperbola**, is an Hyperbola whose Oval Conjugate is infinitely small, that is, a *Point*. See *Curves*.

**PUNCTUM**. See *Point*.

**PUNCTUM Formatum seu Generatum**, in Conicks, is a Point determined by the Interfection of a Right Line drawn thro' the Vertex of a Cone to a Point in the Plane of the Base, with the Plane that constitutes the Conick Section. See *De la Hire's Latin Conicks*, p. 15, 16.

**PUNCTUM ex Comparatione**, is either *Focus* in an Ellipsis and Hyperbola; and it was so called by *Apollonius*, because the Rectangles under the Segment of the Transverse Diameter in the Ellipsis, and under that and the Distance between the Vertex and Focus in the Hyperbola, are equal to  $\frac{1}{4}$  part of what he calls the *Figure*.

**PUNCTUM Lineans**; is that point of the generating Circle, which in the Formation of either Simple Cycloids or Epicycloids, produces any part of a Cycloidal Line. See *Epicycloid*.

**PUNCTUM Lachrymale**. See *Lachrymale Punctum*.

**PUNCTUM Saliens**: In the Growth of an Egg, you see a little Speck or Cloud, as it were, in the innermost Tunic of it, called *Amnios*, which growing gradually thicker, acquires a kind of slimy Matter, in the middle whereof you see first this *Punctum Saliens*, (a little Speck that seems to leap) afterward the rude Body of an *Embryo*, which tends every Day more and more to Perfection. *Blanchard*.

**PUNITORY Interest**, is a Term in the Civil Law, for such Interest of Money as is given for Delay, or Breach of Trust.

**PUNY**. See *Puisse*.

**PUPILLA**, or *Pupula*, is the opening of the Tunic of the Eye, called *Uvea*, or *Choroides*; it is round in a Man, and is capable of being contracted or dilated like a Muscle, according to the different Degree of Light the Eye is exposed to.

**PUPPIS Vena**, is that Vein which spreads it self about the hinder Part of the Head.

**PURCHASE**: This Word hath the same Sense at Sea, as *Draw* has a Shore; thus they say, *The Capstan Purchases apace*; that is, draws in the Ca-

ble apace. And when they cannot draw or hale in any thing with the Tackle, they say, *The Tackle will not Purchase*.

**PURE Hyperbola**, is one which by the Impossibility of its two Roots is without any *Oval*, *Node*, *Spike*, or *Conjugate Point*. See *Curves*.

**PURFLEW**; the Term in Heraldry to express *Ermines*, *Pean*, or any of the Furs, when they compose a *Bordure* round a Coat of Arms. Thus they say, he Beareth *Gules*, or *Bordure Purflew*, *Verry*; meaning that the *Bordure* is *Verry*.

**PURGATION**, *Purging*, is an Excretory Motion quick and frequent, proceeding from a quick and orderly Contraction of the Catneous Fibres of the Stomach and Intestines, whereby the Chyle and Excrements, and corrupted Humours, either bred or sent there from other Parts, are protruded from Part to Part, till they be quite excluded the Body. *Blanchard*.

**PURGATION**, in Law, is the clearing of a Man's self of a Crime whereof he is generally suspected, and of the same accused before the Judge; and is either *Canonical* or *Vulgar*. The *Canonical*, is that which is prescribed by *Canon Law*, the Form thereof is usually thus in the Spiritual Court: The Man suspected takes his Oath, that he is clear of the Fault objected, and brings so many of his honest Neighbours, being not above Twelve, as the Court shall assign him, to Swear upon their Conscience and Credulity, that he Swear-eth truly. *Vulgar Purgation* was by *Fire* or *Water*, or by *Combat*, used both by Infidels and Christians, till by *Canon Law* abolished: But *Combat* may be still practised by the Laws of the Realm in Causes doubtful, and where there is want of Evidence and other Proof, if the Defendant chuse rather the *Combat* than other Tryal.

**PURGATIVE Medicines**; the manner of their Operation is very well accounted for by Dr. *Cheyne* in his Book of *Fevers*, thus: Purgative Medicines being receiv'd into the Stomach by the Mouth, their Particles do there vellicate or stimulate the Fibres of the Stomach, and thereby encrease the Digestive Faculty; *i. e.* bring the Muscular Fibres of the Stomach, and the Muscles of the *Abdomen* and *Diaphragm* into more frequent Contractions than ordinary, till they are admitted into the *Intestines*; the *Fibres* and *Glands* of which being more sensible than those of the Stomach (whose Parts, by the frequent rough Contacts of one against another, and of the gross Bodies which are often thrown into it, are as it were deadned) they easily move and bring them into frequent forcible Contractions, whereby these Glands are squeezed, and so emit a Fluid which lubricates the Passages. And this mixing with the *Fæculent Matter* of the Intestines (which is rendred fluid by the same active and stimulating Quality of the Purgative Medicine) renders it more fluid, by which, and by the uncommon Contractions of the Intestines, it passes more easily and plentifully into the *Rectum Intestinum*, and is thence ejected by Stools. Thus gentle and easier Purges act, and do only cleanse the Intestines, few of their Particles entring in by the lacteal Veins and so affecting the Blood: But in violent Purgatives, the stimulating Particles are mixed with the Blood, and produce there many times very great Effects by occasioning unnatural Fermentations, by separating the natural Cohesions of the Liquors of the Body; and also by vellica-



vellicating the Spiral Fibres of the Veins and Arteries, bring those into more forcible Contractions, and thereby accelerate the Motion of the Blood; all which may sometimes have a good and sometimes a bad effect.

**PURIFICATION** of a *Metal*, in Chymistry, signifies its being purged or cleansed from the Mixture of all other Metals.

'Tis chiefly used about Gold and Silver. The best

*Purification* of Gold, is by Antimony, in this manner: Put the Gold in a Crucible, make it red hot, and when it begins to melt, pour upon it by degrees four times its Weight of Antimony in Powder; the Gold will presently melt; continue a very strong Fire, till you perceive the Metal to sparkle; then take the Crucible out of the Fire, and knock it, that the Gold may sink to the Bottom; break it when 'tis cold, and separate the fine Gold, which is called the *Regule*, from the drossy Part.

After this, melt the *Regule* again over a strong Fire in a Crucible; and when it begins to melt, throw into it, by little and little, three times its Weight of *Salt-Petre*; continue a very strong Fire to keep the Matter in constant Fusion; and when the Fumes are all gone, and the Metal appears bright and clear, cast it into an Iron Mortar greased and warmed, or else if you don't value the Crucible, leave it in that to cool, and break the Crucible before 'tis quite cold, and then separate the *Regule* from its Dross remaining at the Top, the Gold will be very pure.

There are several other ways of purifying Gold, as the *Depart* and *Cementation*, which see under those Words: But this is the best of all.

Red Gold is less valuable, as containing most Copper; the Yellow is better, and it should remain Yellow, while 'tis in the Fire.

*Purification* of Silver, is made in the Coppel thus:

Heat the Coppel gently and by degrees, till it grow red hot; then cast into it four or five times as much Lead as you design to purify Silver: The Lead will soon melt, and fill the Sides of the Coppel; then put the Silver into the midst of the melting Lead, and it also will presently melt; then lay Wood all about and over the Coppel, and blow the Flame so that it may reverberate on the Matter; the Impurities of which will by this means mix with the Lead, and the Silver will remain pure and unmixed in the middle of the Coppel: and the Lead, mixed with the drossy Parts of the Silver, will lie on the sides like a Scum: This Scum is to be taken off with a Spoon, or other Instrument, and it is what is called *Litharge*; which, according to the Degree of the Calcination it hath endured, is of divers Colours, and sometimes is called *Litharge* of Gold, and sometimes *Litharge* of Silver.

**PURLUE**, or *Purlieu*, from the French *Pur*, i. e. *Purus*, and *Lieu*, i. e. *Locus*, is all that Ground near any Forest, which being anciently made Forest, is afterwards, by Perambulations, severed again from the same, and exempted from that Servitude that was formerly laid upon it: And he that Walketh or Courseth within that Circuit, is not liable to the Laws and Penalties incurred by them which hunt within the Precincts of the Forest.

**PURLINS**, in Architecture, are those Pieces of Timber which lie across the Rafter on the Inside,

to keep them from sinking in the middle of their Length.

**PURPARS**, a *Purparty*, is that part or share of an Estate, which being held in Common by Co-partners, is by Partition allotted to any one of them.

**PURPRISUM**, [in *Law*] a close or inclosure; also the whole Compass or Extent of a Manour.



**PURPURE**, the Heralds Term for a Colour consisting of much Red and a little Black: And this Term is used in the Coats of all Persons below the Degree of Noble; but in the Coats of Noblemen, 'tis called *Ametist*; and in those of Sovereign Princes, 'tis called *Mercury*. 'Tis expressed in Engraving by Lines drawn athwart the Escutcheon, beginning at the *Dexter Point*.

**PURSER**, an Officer in the King's Ship, who receives her Victuals from the Victualler, and is to take Care that it be in good Condition, and well laid up and stowed: His Office is also to keep a List of the Men and Boys belonging to the Ship, and to set down exactly the Days of each Man's Admittance into Pay, that so the Pay-Master, or Treasurer of the Navy, may issue out his Disbursements, and Pay Men off according to the *Purser's Book*.

**PURSUIVANT**. See *Poursuivant*.

**PURVEYANCE**. See *Purveyance*.

**PURVEYOR**. See *Purveyor*.

**PUS**, [in *Physick*] a putrid, white, thick Matter, formed of corrupted Blood, and issuing out of the Lips of a Wound when opened, or an Imposthume when broken. *Greek*.

**PUSTULE**, [*Pustula*, L.] a small Pimple or Eruption on the Skin full of *Pus*; especially arising in the *Pox*, either small or great.

**PUTAGIUM**, [in *Old Law Books*] Whoredom, or the Life and Condition of a Courtesan.

**PUTLOGS**, or short pieces of Timber (about 7 Foot long) used in building Scaffolds; they lie at Right-Angles to the Wall with one of their Ends resting upon the *Ledgers* or Poles which lie parallel to the side of the Wall of the Building.

**PUTREFACTION**, is a slow kind of Corruption in Bodies, wrought generally by the Moisture of their Air, or some other ambient Fluid, which penetrating into the Pores of Bodies, and being agitated in them, doth fetch or force out some of the more subtil and agile parts of Bodies, loosen and dislocate the Parts in general one from another, and thereby quite change the Texture, and sometimes the Figure of the *Mixt*, from what it was before.

**PUTRID Fever**, [in *Medicine*] is such where the Humours, or Part of them, have so little circulatory Motion, that they fall into an intestine one and putrify.

**PUTTOCKS**, or *Puttock Shrowds*, are small Shrowds which go from the Shrowds of the Main-Mast, Fore-Mast, and Mizen-Mast, to the Top-Mast-Shrowds. And if there be any Top-Gallant-Masts on the Top-Masts, there are *Puttocks* to go from the Top-Mast Shrouds into those. These *Puttocks* are at the Bottom seized to a Staff, or to some Rope which is seized to a Plate of Iron, or to



to a dead Man's Eye, to which the Laniards of the Fore-Mast-Shrowds do come.

PUTURA [in *Old Customs*] a Right by Custom claimed by the Keepers of Forests; and also, sometimes by Bailiffs of Hundreds of taking a Man's Horses and Dogs mean of the Tenants and Inhabitants *gratis*, within the Perambulation of the Forest, Hundred, &c.

PYCNOTICKS [*πυκνотικά* of *πυκνόν*, Gr. *to thicken*] Medicines of an aqueous Nature, and having the Quality of cooling, condensing and thickening of Liquors.

PYCNOTYLE, [*πυκνотύλον*, Gr.] in Architecture, is a Building where the Pillars stand very close one to another, one Diameter and a half of the Column being only allowed for the *Intercolumniation*.

PYLORUS, [*πυλорός*, Gr.] or Janitor, is the lower Orifice of the Ventricle, which lets the Meat out of the Stomach into the Intestines. Dr. Willis calls the Beginning of the *Pylorus*, where its Coats are thickest, the *Antrum*.

PYRAMID, [*πυραμίδας* of *πῦρ*, Fire] in Geometry, is a Solid Figure whose Base is a Polygon, and whose Sides are plain Triangles, their several Tops meeting together in one Point.

The Solid Content of a *Pyramid*, is  $\frac{1}{3}$  to  $\frac{1}{3}$  of the perpendicular Altitude multiplied by the Base; because a *Pyramid* is  $\frac{1}{3}$  of a Prism of the same Height and Base. 7 *è* 12. *Eucl.* which see also proved under the Word *Parallelopiped* (the same with Prism.)

The superficial Area of a *Pyramid*, is found by adding the Area of all the Triangles, whereof the Sides of the *Pyramid* consist, into one Sum: For the whole external Surface (except the Base) of any *Pyramid*, is nothing but a System of as many Triangles as the *Pyramid* has Sides.

If a *Pyramid* be cut with a Plane parallel to the Base, the Surface of that truncated *Pyramid* comprehended between the parallel Lines, is found by subtracting the Surface of the *Pyramid* cut off from the Surface of the whole *Pyramid*.

Also the external Surface of a right *Pyramid*, that stands on a regular *Polygon* Base, is equal to a Triangle, whose Altitude is equal to the Altitude of one of the Triangles which compose it, and its Base to the whole Circumference of the Base of the *Pyramid*.

Whence therefore the Surface of a right *Cone*, (for a *Cone* is but a *Pyramid* of infinite Sides) is equal to a Triangle, whose Height is the Side of the *Cone*, and the Base equal to the Circumference of the Base of the *Cone*.

PYRAMIDALES *Papillæ*. See *Papillæ Pyramidales*.

PYRAMIDAL Numbers, are the Sums of *Polygonal* Numbers, collected after the same manner as *Polygonal* Numbers themselves are extracted from Arithmetical Progressions.

PYRAMDALIA, are Vessels which prepare the Seed; of which in their proper Place. Also Muscles of the Nostrils, and of the *Abdomen*, called *Pyramidales*, or of a pyramidal Figure. Also two Strings of Marrow about the Basis of the oblongated Marrow.

PYRAMIDALIA *Corpora*. See *Corpora Pyramidalia*.

PYRAMIDALIS, *five Succenturiatus Musculus*, one of the Muscles of the *Abdomen*, lying on the *Rectus*, helping in Conjunction with the rest, to compress the *Abdomen*, and to exclude its Contents. Mr. Cowper thinks it to have also a peculiar Use in compressing the Bladder.

PYRAMIDOID, is what is sometimes called a *Parabolick Spindle*; and is a solid Figure formed by the Revolution of a *Parabola* round its *Base* or *greatest Ordinate*; and if you consider it according to the Method of Indivisibles, you may conceive its Solidity to consist of an infinite Series of Circles whose Diameters are all parallel to the *Axis* of the *Revolving Parabola*.

PYRAMIDOID. See *Parabolick Pyramidoid*.

PYROIDES *Processus*, [in *Anatomy*] a Process of the second *Vertebra*; so called from its Shape bearing a resemblance of a *Pear*, in Latin *Pyrum*.

PYRETICKS, [of *πύρετος*, Gr. *a Fever*] Medicines good against Fevers.

PYRIFORMIS, *seu Iliacus externus*, is a Muscle of the Thigh, which receives its first Name from its Figure, the second from its Situation: Its Beginning is round and fleshy from the inferior and internal Part of the *Os Sacrum*, where it respects the *Pelvis* of the *Abdomen*, and descending obliquely in the great *Sinus* of the *Os Ilium*, above the acute Process of the *Ischium*, and joining with the *Glutæus Medius*, it's inserted by a round Tendon to the superior Part of the Root of the *Great Trochanter*. This moves the *Os Femoris* somewhat upwards, and turns it outwards.

PYROTECHNIA, [*πυροτεχνία* of *πῦρ*, Fire, and *τέχνη*, Gr. *Art*] the same with *Chymia*.

PYROTECHNY, [*πυροτεχνία* of *πῦρ*, Fire, and *τέχνη*, Gr. *Art*] the Art of Fire, or a Science which treats of, or teaches the Management and Application of Fire in several Operations.

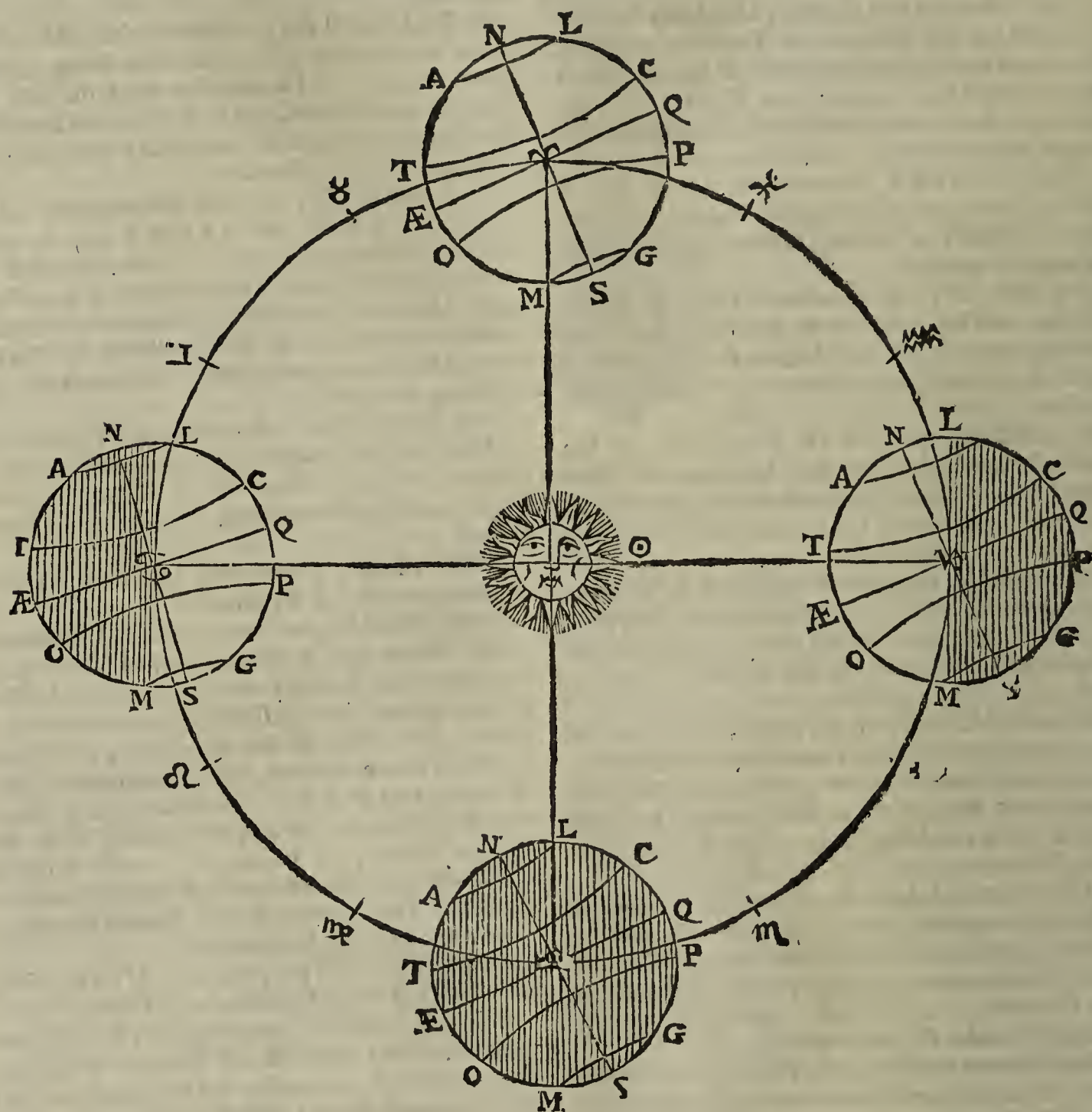
Military PYROTECHNY, is the Doctrine or Art of making artificial Fire-Works, and Fire-Arms.

Chymical PYROTECHNY, is the Art of managing and applying Fire in Distillations, Calcinations and other Operations of Chymistry.

PYROTICA, [*πυροτικά*, Gr.] or *Urentia*, are Medicines virtually Hot, which being applied to Human Bodies, grow extremely hot; because that having Particles and Pores so ordered, that Vapours and Humours insinuate into them, the subtil Matter finds such Passages, that it being moved extreme violently, forces certain earthy, hard, and acute Particles, which float in the Passages upon the neighbouring Parts with great Impetuosity, and so excites an Heat which corrupts or changes differently, according to the Diversity of its Motion and the Particles that are moved. Such are things that cause Redness, that blister, that ripen or rot, that close up, and bring Wounds to a Crust, and that pull Hairs out of the Body. *Blanchard*.

PYRRICHIUS, is the Foot of a *Latin Verse* consisting of two Syllables, and both short.





**PYTHAGOREAN System**, is the same with the *Copernican*, but is so called, as being maintained by *Pythagoras* and his Followers, and therefore is the most ancient of any. In this the Sun is supposed at Rest in the Centre of our System of Planets, and the Earth to be carry'd round him annually in a Track or Path between *Venus* and *Mars*. I shall only add here an Account how the *Phænomena* of Day and Night, and the *vicissitudes* of Seasons are accounted for, according to the *Pythagorean* System, where the Earth moves round the Sun.

Let  $\gamma \odot \approx \varpi$  represent the Earth's Annual Orbit round the Sun at  $\odot$ . The Plane of which Orbit if infinitely produced among the fix'd Stars, will describe that Circle which we call the *Ecliptick*. In this Orbit let the Earth be supposed to move from  $\gamma$  to  $\delta$ , next to  $\Pi$ ,  $\mathcal{E}$ , &c. and let the Earth be represented by the Epicycles  $NAESQN$ , in which  $N$  and  $S$  are the North and South Poles, and the Line  $NS$  the Earth's Axis always keeping parallel to it self; and  $AEQ$ , the Equator, whose Plane is inclined to the *Ecliptick* with an Angle of  $20^\circ 30'$ , which is the Complement of  $66^\circ 30'$ , the Angle that the Earth's Axis (perpendicular to the Plane of the Equator) makes with the *Ecliptick*.

Suppose then the Earth in  $\approx$  (then will the Sun appear to be in  $\gamma$ , the first Point of its Annual Orbit) and the Earth so turning it self to the Sun, that the Axis of its Motion may be perpendicular to a Line drawn from the Center of the Sun to that of the Earth, then will the Earth's Equator appear coincident with the Celestial Equinoctial; and the Sun will appear to be just in the middle between the two Poles, and to send his Light equally towards both of them, and as far as both of them (for the Sun always illuminates one half of the Globe.) Wherefore as that Hemisphere of it (*viz.*  $TNLCP$ ) which is now turned towards him, is *Enlightned*, so the other (behind) is now supposed to be in *Darkness*. And because the Earth revolves round its Axis  $NS$  in 24 Hours, which Axis is now at Right-Angles with the Line  $\gamma \odot \approx$  connecting the Centres of the Earth and Sun, every Point of the Equator  $AEQ$ , and of the Tropicks  $TC$  and  $OP$ , and of all other Parallels to the Equator, will be as much in the Light as in the Dark, in every Diurnal Revolution; and consequently the Days and Nights will be Equal, at that Time, all over the Earth.

But as the Earth moves further on in the Annual Orbit towards  $\varpi$  and  $\gamma$ , the Plane of the Terrestrial Equator will be then no more direct to the



Sun, but will subside towards the South, and therefore the Sun will appear to go as much toward the North Pole, and as it were from the Equator in the Heavens; for the Earth being apparently at Rest, its Equator will be so too, and consequently the Celestial Equinoctial will appear to change from its Position by a diurnal Motion, and the Sun will appear to move also, because it changes its Position in respect to the Equinoctial in the Heavens. And the Sun's Light which before reached just as far as the Poles N and S, will now go beyond N, and will fall as much short of S.

But when the Earth is come to  $\varpi$ , the Sun then will appear to be in  $\odot$ , where he will seem most of all to decline from the Equator towards the North, viz. as much as is the Angle of Inclination between the Plane of the Equator and that of the Ecliptick; and the Sun will then seem to move all Day in the Circle T C, which is a Parallel to the Equator at  $23^{\circ} 30'$  distance, and is called the Tropic of  $\odot$ . The Earth being thus posited, 'tis apparent that the Sun's Rays enlightning always one half of it, will now reach beyond the Pole N, as far as L, and fall short of the Southern Pole S, by the Ark S M = to LN = to  $23^{\circ} 30'$  the Inclination of the Ecliptick to the Equator; and therefore if 2 lesser Circles are imagined to be there drawn on the Earth, they will be the Polar Circles, as A L and M G: And 'tis plain that that Part of the Earth which lies between the Polar Circle A L and the Pole, will enjoy perpetual Day, notwithstanding the Earth's diurnal Motion, as the opposite Part within the Antarctick Circle M G will be in continual Darknes. The Earth being thus in  $\varpi$ , and the  $\odot$  appearing in  $\odot$ , 'tis plain also that of every Circle parallel to the Equator in the North-

ern Hemisphere, the greatest Part, or more than a Semicircle, will be illuminated; but from the Equator towards the South Pole, the greatest Part of every Parallel will be in Darknes: Wherefore in all Places lying to the Northward of the Equator, the Days will be longer than the Nights; that is, it will be Summer; as in the Southern Hemisphere the Nights will be longer than the Days, where it will be Winter; and this in Proportion to the Place's Distance from the Equator: But to those who live under the Equator, or the Line, (as the Seamen call it) the Days and Nights will be equal now, and at all Times of the Year.

The Earth moving on in its Annual Orbit from  $\varpi$  into  $\sphericalangle$ ,  $\times$ , and so to  $\gamma$ , it will arrive at the other Equinoctial Point, and then the Sun will appear to be in  $\sphericalangle$ , and all Things will be the same as when the Earth was in  $\sphericalangle$ , which have been above deliver'd.

The Earth going on in its Orbit from  $\gamma$ , to  $\Pi$ , and so to  $\odot$ , the Sun will then appear to be in  $\varpi$ , and consequently in the Winter Tropic, as we call it in reference to our Position toward the Sun: And now the State of Things with us will be the Reverse of what it was when the Earth was in  $\varpi$ , our Nights will be longer than our Days, &c. as appears from the Figure; and it will fare with us Inhabitants of the Northern Hemisphere, in all respects, as it did then with the Inhabitants of the Southern.

PYTHAGORICK *Tetractys*, was a Point, a Line, a Surface, and a Solid.

PYTHAGORICK *Theorem* or *Proposition*, is the 47th of the first Book of *Euclid*.

PYXIS, is the Cavity of the Hip-Bone, which is called *Acetabulum*.

QUADRA, [in *Architecture*] any square, border, or frame, that encompassed a *Basso Relievo*, Pannel, Painters or other Work; and some use it, but erroneously, for a Frame, or Border of another Form, as a round Oval or the like.

QUADRAGATA *Terræ*; a *Team* of Land: or which may be tilled with four Horses.

QUADRAGESIMA, is the first *Sunday* in *Lent*, and so called, because 'tis about the fortieth Day before *Easter*; and on the same Account the three preceding *Sundays* are called *Quinquagesima*, *Sexagesima*, and *Septuagesima*.

QUADRAGESIMALS: In *Papish* Times 'twas the Custom for People to visit their *Mother-Church* on *Midlent Sunday*, and to make their Offerings at the High-Altar. And the like kind of Superstitious Devotion was also used in *Whitson-Week*: But as the Processions and Oblations at *Whitson-tide* were sometimes commuted for a rated Payment of *Pentecostals* or *Whitson-Farthings*; so these were changed into a Customary Payment, and were called *Quadragesimals*; *Denarii Quadragesimales*; and sometimes *Lætare Jerusalem*, because that Hymn was sung on *Midlent Sunday*. The Custom of *Mothering*, as 'tis called in many places in *England*, is still retained, being that of visiting

Parents on *Midlent Sunday*; and it seems to be called *Mothering* from the Respect thus in old Time paid to the *Mother Church*. And the Epistle of *Galat.* 4. 21. is still retained on *Midlent Sunday*, which began *Jerusalem mater omnium*, &c. tho' the occasion of it is forgotten.

QUADRANGLE, or *Quadrangular Figure*, in Geometry is that which hath no more than four *Angles*.

QUADRANS, the fourth part of a Penny, or a Farthing; for before the Reigu of *Edw.* 1. our smallest Coin was a Penny, called then *Sterling*; and it was stamp'd with a Cross or Traverse Stroke, so that it might on occasion be cut easily or broken into Halves or Quarters: But to avoid the Fraud of unequal division of the Penny, this *K. Edw.* 1. coined Half-pence and Farthings in round distinct Pieces. *Matt. West. in Anno* 1279.

QUADRANT, is an Arch which is the fourth Part of a Circle, containing 90 degr. And oftentimes the space contained between a Quadrantal Ark, and two *Radii* perpendicular one to another in the Centre of the Circle, is called a *Quadrant*; from the Figure of which the following Instrument takes its Name, which is called a



*Quadrant*, and is a very useful and ready Instrument, when well made, for many Operations. The Limb of it is divided into 60 Degrees, and as many parts of a Degree as the Bigness of the Instrument will bear, and this by means of a String and Plummet, (or Label, if it be a screwed Limb) gives you the Sun's Altitude, or that of any Star or other Object above the Horizon, reckoned from that Edge of the Quadrant where the Sights are not placed. In *Collin's* Quadrant, this Limb is also divided into Time, and numbred accordingly, and then it serves very readily to find the Sun's right Ascension either in Degrees or Time, and to shew the Hour of the Day there to a Minute, by his Altitude. Next to the Limb, in *Gunter's* Quadrant, is the Calendar of the Months placed; but in *Collin's* 'tis put in four little Quadrantal Arks next the Center of the Instrument, having an Ark also of the Sun's Declination fitted thereunto; so that the String laid to the Day of the Month, will shew the Declination; or laid to the Declination, will give the Day of the Month, in the Quadrantal Ark proper for that Season of the Year. Next below this, in *Mr. Collin's* Quadrant (which I judge to be the best) is the Projection, which is a fourth part of *Stoffler's Astrolabe*, inverted and fitted to the Latitude of *London*; of which those Lines which run from the Right Hand towards the Left are parallels of Altitude, and those which cross them are Azimuths. In the Projection are drawn the two Eclipticks, with the Characters of the Signs upon them, and the two Horizons, all issuing from the same Point; and up and down in the Projection are placed such eminent fixed Stars, as are between the Tropicks. Next below the Projection is the *Quadrant* and Line of Shadows, being only a Line of Natural Tangents to the Arks of the Limb; and by its help, the Heights of Towers, Steeples, &c. may be pretty exactly taken.

QUADRANT of *Altitude*, is part of the Furniture of an artificial Globe, being a thin Brass Plate divided into 90 Degrees, and marked upwards with 10, 20, 30, &c. being rivetted to a Brass Nut which is fitted to the Meridian, and hath a Screw in it, to screw upon any Degree of the Meridian: when it is used, 'tis most commonly screw'd to the Zenith. Its Use is for measuring *Altitudes*, to find *Amplitudes* and *Azimuths*, and describing *Almicantars*.

QUADRANT *Astronomical*; see *Astronomical Quadrant*.

QUADRANT of *Davis*. See *Back-staff*.

QUADRANTATA *Terræ*, the fourth part of an Acre.

QUADRANT *Triangular*. See *Triangular Quadrant*.

This Figure represents an *Astronomical Quadrant* upon its Pedestal, with its Limb curiously divided Diagonally, and furnished with a fixed and moveable Telescope,

This *Quadrant* may be moved round Horizontally, by turning a perpetual Screw fitted into the Pedestal; for as this Screw is turned about by means of a Key, at the same Time it causes the Axis A to turn, by the falling of its Threads between the Teeth of a strong thick Circle on the said Axis.

Behind the *Quadrant* is fixed, at Right Angles to its Plane, a strong thick portion of a Circle greater than a Semi-circle, having one Semi-circle of the out-side thereof cut into Teeth; there is likewise another strong thick portion of a Circle, something greater than a Semi-circle behind the *Quadrant*, which is moveable upon two fixed Studs, at Right Angles to the former Portion; so that the Plane of this Portion may be parallel, inclined, or at Right Angles to the Plane of the Quadrant, on the side of this Portion, which is made flat next to the other fixed Portion, is a contrivance with a Screw and perpetual Screw, such that in turning the Screw, the Threads of the perpetual Screw may be locked in between the Teeth of the fixed circular Portion; and by this means the Quadrant fixed to any Point, according to the Direction of the Plane of the fixed Portion; and when the Quadrant is to be moved but a small Matter in the aforesaid Direction; this may be done by turning the perpetual Screw with a Key.

The outside of the above-mentioned moveable circular Portion is cut into Teeth, and about the Centre thereof the Axis A is moveable, according to the Direction of the Plane of the said Portion, in this Axis, slides a little piece carrying a perpetual Screw, whose Threads, by means of a Trigger, may be lock'd in between the Teeth of the moveable circular portion, and so when the Axis is set in the Pedestal, the Quadrant may be fixed to any point, according to the Direction of the Plane of the said moveable Portion.

Therefore by these Contrivances the Quadrant may be readily fixed to any required situation, for observing celestial *Phænomena*, without moving the Pedestal.

There is a Piece sliding on the Index, upon which the moveable Telescope is fastened, carrying a Screw and perpetual Screw; so that when the Telescope and Index are to be fixed upon any Point in the Limb of the Instrument, this may be done, by means of the Screw which locks the Threads of the perpetual Screw in between some of the Teeth, cut round the Curve Surface of the Limb of the Instrument; and when the Index and Telescope is to be moved a very Minute's Space backwards or forwards along the Limb, this is done by means of a Key turning a small Wheel fastened upon the afore-named Piece, which is cut into a certain Number of Teeth, and whose Axis is at Right Angles to the Plane of the Quadrant; for this Wheel moves another (having the same Number of Teeth as that) which is at the End of the Cylinder whereon the perpetual Screw is; and by this means the perpetual Screw is turned about; and so the Index and Telescope may be moved a very Minute Space backwards or forwards along the Limb. *Note*, The Number of Teeth the Curve Surface of the Limb is divided into, must be as great as possible, and the Threads of the perpetual Screw falling between them very fine; for the Exactness of the Instrument very much depends upon this.

These Quadrants are commonly two Feet Radius, and all Brass, except the Pedestal and the perpetual Screws, the Telescopes have each two Glasses and Cross-Hairs in their *Foci*; and for the Manner of dividing their Limbs, &c. See our Author's Quadrants.



**QUADRANTAL Triangle**, is a Sperick Triangle, one of whose Sides (at least) is a Quadrant, and one Angle Right.

**QUADRAT**, and Line of Shadows on a Quadrant, are only a Line of natural Tangents to the Arks of the Limb, and are placed there in order to measure Altitudes readily, for it will always be; as the Radius to the Tangent of the Angle of Altitude at the Place of Observation; (that is, to the Parts of the Quadrat or Shadows cut by the String) :: so is the Distance between the Station and Foot of the Object to its Height above the Eye.

**QUADRATE**. To Quadrat a Piece of Ordnance, is to see whether it is duly placed in its Carriage, and that the Wheels be of an equal Height.

### Quadratick Equations.

**QUADRATICK Equations**, are such as retain on the unknown Side, the Square of the Root or Number sought; and are of two sorts.

I. *Simple Quadraticks*, where the Square of the unknown Root is equal to the absolute Number given, as  $a a = 36$ ,  $e e = 146$ ,  $y y = 133225$ . And for the Solution of those, there needs only to Extract the Square Root out of the known Number, and that is the Value of the Root or Quantity sought: Thus the Value of  $a$  in the First Equation is equal to 6, in the Second  $e = 12$  and a little more, it being a Surd Root. And in the Third Example  $p = 365$ .

II. *Adfeſted Quadraticks*, are such as have between the highest Power of the unknown Number and the absolute Number given, some intermediate Power of the unknown Number, as  $a a + 2 b a = 100$ .

And this Equation is properly called *Adfeſted*; because the unknown Root  $a$  is Multiplied into the Coefficient  $2 b$ .

The Original of *Adfeſted Equations*, the Ingenious Mr. Harriot thus derives: Let  $a$  be  $= +b$ , or  $a = -c$ , then by Transposition will  $a - b = 0$ , and  $a + c = 0$ . And then multiplying one by another, the Product is  $a a - a b + c a - b c = 0$ .

And this he properly calls an *Original Equation*. From which or others of the same Kind, Transposing  $b c$  over to the other Side with a contrary Sign, he gains such an Equation as this,  $a a - a b + c a = b c$ , which he calls a Canonical Equation.

And from hence, by putting Examples in all Cases, he shews, that every possible Quadratick Equation hath two real Roots, according to the Dimensions of the highest Power; as being made up by the Multiplication of two simple Equations. And that these two Roots may be either both Affirmative, or both Negative; and that sometimes they are equal to each other, and sometimes not. And from hence he finds, that the absolute Number  $b c$  is always the Rectangle of the two Roots  $b$  and  $c$ , (or of the two Values of  $a$ ): And that if it have a positive Sign, the two Roots have like Signs, but if a Negative one, unlike.

And, That the Coefficient of the middle Term is always the *Aggregate of both the Roots with contrary Signs*; and consequently their *Difference*, when without its Sign. See more in his *Second Section*, and in *Wallis's Algebra*, p. 132, &c.

And when in such Kind of Quadraticks as these, the Index or Exponents of the Dimensions of the unknown Root are in Arithmetical Proportion, that is, as in this Equation,  $a a + 2 b a = 100$ , the Index of  $a a$  is 2, the Index of  $2 b a$  is 1, and the Index of 100 is 0; then may the Root be easily found out by the following Method.

All Equations of this Rank will be in one of these three Forms.

$$\begin{array}{l} a a + a = d R \\ a a - a d = R. \\ a s - a a = R \end{array} \left\{ \begin{array}{l} * \text{ Some make four Forms,} \\ \text{but at long run it comes} \\ \text{to the same thing.} \end{array} \right.$$

In all which Forms,  $R$ , the absolute Number given, is a Rectangle or Product made out of the two Quantities or Roots sought, a Greater and a Lesser.

Of which in the *First Form*, where all is Affirmative, the Coefficient  $d$  is the Difference between those two Quantities or Roots; and  $a$  is the Lesser of them, as is plain if you suppose the two Roots (as *Oughtred* doth) to be  $a$  the greater, and  $e$  the Lesser. For then let  $d = x$  be the Difference between them: So that  $e + x = a$ . If then you multiply each Part by  $e$ , it will be  $e e + e x = a e$ ; from whence it appears also plainly, that  $a e$  is equal to  $R$ , the absolute Number given, or equal to the Rectangle of the two unknown Roots  $a$  and  $e$ , of which in this Form, the Coefficient  $x$  or  $d$  is equal to the Difference between them, and  $e$  is the Lesser of them.

In the *Second Form*, The Coefficient  $d$  is the Difference of the two Roots as before, but  $a$  there represents the Greater of them, as is plain by putting (because the Sign is Negative)  $a - x = e$ , and multiplying each Part by  $a$ , it produces  $a a - a x = a e$ , the second Form, where  $x$  or  $d$  the Coefficient is the Difference of the two unknown Roots; and  $a$  represents the greater of them.

In the *Third Form*, where the highest Power is Negative, the Coefficient  $s$  is the Sum of the two Quantities of Roots sought; and  $a$  the Affirmative Root sought, may be either the Bigger or the Lesser of them. For let (because the highest Power is Negative)  $x - a = e$ ; then multiplying both by  $a$  it will  $x a - a a = a e = R$ . or if  $x - e$  had been put equal to  $a$ , then it would have been  $x e - e e = a e$ , by multiplying all by  $e$ .

So that this Method shews you the Original Constitution of these Forms, and the Nature and Office of each Member of them.

From all which may be found this general Canon for the Solution of Quadratick Equations, according to this Method.

Multiply the absolute Number by 4, and to the Product add the Square of the Coefficient, then extract the Square Root of that Sum: Which Root shall be the Sum of the two Numbers sought. Then



to or from the half of that Root, add and subtract half the Coefficient, and the Sum and Remainder are the two Roots required.

For the particular Solution of affected Quadratics there are three Ways.

I. *That of Oughtred, who proceeds in this Method.*

In all the three Forms, there is given either the Rectangle and Sum, or the Rectangle and Difference of the two unknown Quantities; whence 'tis very easy to find either the Difference in the former, or the Sum in the latter Case: And then having the Sum and Difference of any two unknown Quantities, the Quantities themselves will soon be known.

Thus in the first Form, let  $aa + da = R$ .

Here is given R the Rectangle of the Roots,  $d$  their Difference; and 'tis known that  $a$  represents the lesser of them. Let S stand for the Sum to be sought.

Let  $a + e = S$  and  $a - e = d$ , Then  $aa + 2ae + ee = SS$ , and  $aa - 2ae + ee = dd$ , Subtract the latter from the former, and there remains only  $4ae = 4R$ . Wherefore  $SS - dd = 4R$ .

You may therefore by simple Algebra find that  $4R = SS - dd$ , and consequently that  $4R + dd = SS$ , and therefore S is known; and then having S and  $d$ ,  $a$  the lesser Root will be known too, for  $\frac{1}{2}S - \frac{1}{2}d = a$ .

Again, in the second Form. Let  $aa - ad = R$ .

Here  $d$  and R (as before) the Difference and Rectangle of the two Roots are given; and  $a$  the greater of them; wherefore 'tis easy to find S the Sum, and then  $\frac{1}{2}S + \frac{1}{2}d = a$ .

In the third Form, where  $sa - aa = R$ .

There is given the Coefficient S = Sum of the unknown Roots, A the Rectangle between them; and  $a$  may be either the bigger or lesser of them; Here therefore to find  $d$  the Difference.

Because  $SS - dd = 4R$ , therefore  $SS + 4A = dd$ , and consequently  $d$  is known; and then  $\frac{1}{2}S + \frac{1}{2}d =$  greater, and  $\frac{1}{2}S - \frac{1}{2}d =$  lesser.

II. *The Solution of Affected Quadratick Equations, by the Method of Compleating the Square.*

Which is by Mr. Harriot, thus: Since in every one of the three Forms of Quadratics, one quarter of the Square of the Coefficient will make the unknown Side of the Equation a compleat Square, whose true Root will be  $a + \frac{1}{2}d$  (or whatever Letters else be the Coefficient.) 'Tis plain by this means, an Affected Quadratick Equation, may be reduced to a Simple one.

Wherefore,

In the first Form, where all the Species are Affirmative.

$$\text{Let } aa + da = R.$$

If  $\frac{1}{4}dd$  be added to the unknown Side, it will be a perfect Square  $aa + da + \frac{1}{4}dd$ , whose true Root is  $a + \frac{1}{2}d$ .

Add then,  $\frac{1}{4}dd$  to R, and  $R + \frac{1}{4}dd$  will be a perfect Square Number and known: Whose Square Root extracted in Numbers, will be equal to  $a + \frac{1}{2}d$ ; and consequently,  $a$  will be equal to that Root, when  $\frac{1}{2}d$  is taken from it, and so  $a$  will be known.

The Practical Rule is this,

To the absolute Number, add  $\frac{1}{4}$  of the Square of the Coefficient, (or the Square of half the Coefficient) and extract the Root of the Sum; then from that Root found in Numbers, subtract  $\frac{1}{2}$  the Coefficient, and the Remainder is  $a$ , the lesser of the two Roots, or Values of  $a$ .

Example.

$$\begin{array}{r} aa + da = R \\ \text{or } aa + 16a = 36 \\ \text{to } 36 = R \\ \text{add } 64 = \frac{1}{4}dd \\ \hline \sqrt{100} = 10 = a + \frac{1}{2}d. \\ \text{but } \frac{1}{2}d = 8 \end{array}$$

therefore  $2 = a$ .

In the Second Form.

$$\text{Let } aa - da = R.$$

Proceed in all respects as in the first Form, only you must at last add  $\frac{1}{2}$  the Coefficient to the Root extracted out of the absolute Number instead of taking it from it, as before: because here  $a$  represents the greater Root; and thus, if  $aa - 16a = 36$ ,  $a$  will be found = to 18.

In the Third Form.

$$\text{Let } sa - aa = R.$$

Here because the highest Power is Negative, 'tis impossible any such Root can be found that will produce  $-aa$ ; wherefore you must imagine all the Signs changed, and then it will stand thus;  $-sa + aa = -R$ , or putting the highest Power first,  $aa - sa = -R$ .

In this Form, the Coefficient is the Sum of the two Roots, and  $a$  may be either of them.

And here the absolute Number is so determined as that it cannot be greater than the Square of half the Coefficient: For,

If the absolute Number be = to the Square of half the Coefficient, the Roots are equal.

The Practical Rule then is this:

From the Square of half the Coefficient, take the absolute Number given; and extract the Square Root of the Remainder; which Root either added to, or subtracted from half the Coefficient,



cient, will give accordingly the greater or lesser Value of  $a$ .

Thus: If  $20a - aa = -36$   
or  $5a - aa = -R$

From  $100 = \frac{1}{4}SS$   
take  $36 = R$

$$\sqrt{\frac{1}{4}SS} = 8$$

now  $10 + 8 = 18$  the greater Root,  
and  $10 - 8 = 2$  the lesser Root.

III. To solve Quadratick Adfected Equations, by taking away the Second Term.

In any of the Three Forms, if the Coefficient have a Negative Sign, put  $e + \frac{1}{2}d$ ; but if it have an Affirmative Sign, put  $e - \frac{1}{2}d$ ; instead of  $a$ , the Root of the highest unknown Power.

$$\text{Then will } ee + ed + \frac{1}{4}dd = aa.$$

$$\text{also } +ed + \frac{1}{2}dd = +da.$$

And these two Quantities added together, must be equal to the Absolute Number given, and the Equation will become a Simple one.

In the First Form,

$$aa + da = R, \text{ or } aa + 16a = 36.$$

$$\text{Let } e - \frac{1}{2}d = a,$$

$$\text{Then will } ee - ed + \frac{1}{4}dd = aa$$

$$\text{and } ed - \frac{1}{2}dd = ad$$

which added together make  $ee - \frac{1}{4}dd = R$

$$\text{Therefore } ee = R + \frac{1}{4}dd$$

$$\text{And consequently } e = \sqrt{R + \frac{1}{4}dd}$$

$$\text{But } e - \frac{1}{2}d = a,$$

$$\text{Therefore } e = a + \frac{1}{2}d$$

$$\text{Consequently } a + \frac{1}{2}d = \sqrt{R + \frac{1}{4}dd}$$

$$\text{Wherefore } a = \sqrt{R + \frac{1}{4}dd} - \frac{1}{2}d. \text{ Q. E. D.}$$

And since  $a + \frac{1}{2}d = \sqrt{R + \frac{1}{4}dd}$ : If each part of the Equation be Squared, there will arise,

$$aa + ad + \frac{1}{4}dd = R + \frac{1}{4}dd.$$

Which is the other common Canon for Solving Quadraticks, by adding to each Part the Square of half the Coefficient, in order to compleat the Square.

In the Second Form,

$$aa - ad - R.$$

$$\text{Let } e + \frac{1}{2}d = a.$$

$$\text{Then is } ee + ed + \frac{1}{4}dd = aa$$

$$\text{and } -ed - \frac{1}{2}dd = ad$$

These added make  $ee - \frac{1}{4}dd = R$

$$\text{Therefore } ee = R + \frac{1}{4}dd.$$

$$\text{and } e = \sqrt{R + \frac{1}{4}dd}.$$

$$\text{but } e + \frac{1}{2}d = a.$$

$$\text{Therefore } e = a - \frac{1}{2}d.$$

$$\text{And consequently } a - \frac{1}{2}d = \sqrt{R + \frac{1}{4}dd}.$$

$$\text{Wherefore } a = \sqrt{R + \frac{1}{4}dd} + \frac{1}{2}d. \text{ Q. E. D.}$$

And since  $a - \frac{1}{2}d = \sqrt{R + \frac{1}{4}dd}$ ; if each Side of the Equation be Squared, you will have,

$$aa - ad + \frac{1}{4}dd = R + \frac{1}{4}dd.$$

Which is the common Canon for solving Equations by compleating the Square.

In the Third Form,

$$da - aa = R.$$

Which Form must be thus changed,

$$aa - da = -R.$$

Then make as before;  $e + \frac{1}{2}d = a$

$$\text{and then } ee + ed + \frac{1}{4}dd = aa$$

$$\text{and } -ed - \frac{1}{2}dd = -ad.$$

$$\text{Whose Sum is } ee - \frac{1}{4}dd = -R$$

$$\text{Then is } ee = \frac{1}{4}dd - R.$$

$$\text{And } e = \sqrt{\frac{1}{4}dd - R}.$$

$$\text{And since, } e + \frac{1}{2}d = a$$

$$e = a - \frac{1}{2}d = (\sqrt{\frac{1}{4}dd - R}).$$

Wherefore (because there are two Positive Roots in this Form)

$$a = \sqrt{\frac{1}{4}dd - R} + \frac{1}{2}d.$$

But the Value of  $a$  is ambiguous, and you must generally try both Roots before you can find which will solve the Question: Whereas in the other two Forms, the first  $a$  found, will be that required.

N. B. In this way of solving Quadraticks, the known Quantity added to, or subtracted from  $e$ , must be always half the Coefficient.

Construction of Adfected Quadraticks.

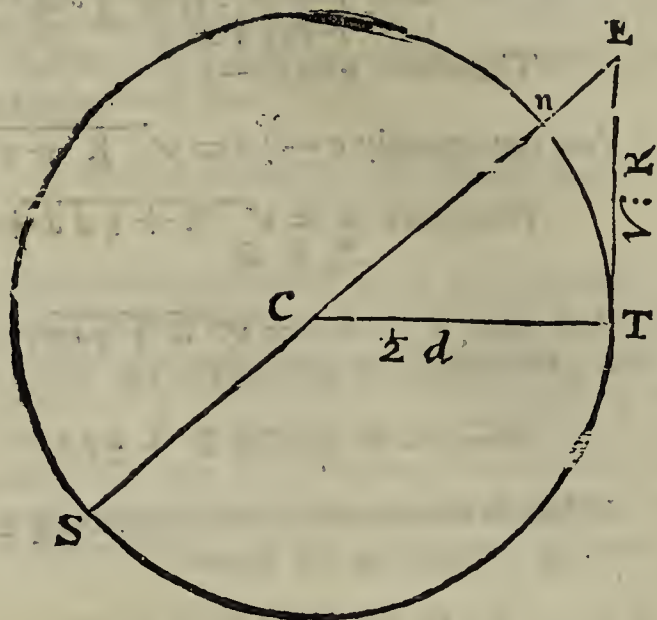
The Construction of Simple Quadraticks, you have before under Simple Equations: That of Adfected ones, is easily done many ways.

I. In the First Form of Quadraticks, let  $aa + da = R$ . Then by the common Method of Solu-

$$\text{tion, } a = \sqrt{R + \frac{dd}{4}} - \frac{d}{2}.$$

Where-





Wherefore describe a Circle whose Radius shall be  $CT = \frac{1}{2}d$ , and make the Tangent  $TE = \sqrt{R}$ , drawing also the Secant  $SCE$ ; then will  $CE =$

$$\sqrt{R + \frac{dd}{4}} \text{ (by 47. e. 1. Euc.) and consequently}$$

$$nE = \sqrt{R + \frac{dd}{4}} - \frac{1}{2}d = a.$$

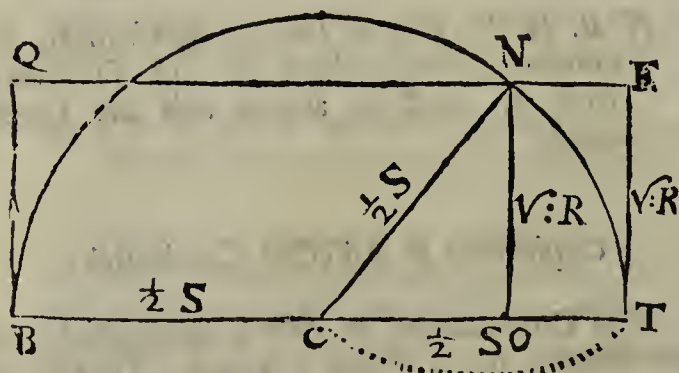
II. In the Second Form, where  $aa - da = R$ ,

$$a \text{ will be equal to } \sqrt{R + \frac{dd}{4}} + \frac{d}{2}. \text{ And consequently, The same Construction and Diagram will serve here, which was used in the first Form: And the Root will be represented by } SE =$$

$$\sqrt{\frac{1}{2}dd} + R\frac{1}{2}d.$$

III. In the Third Form, where  $Sa - aa = R$ ,

$a$  will be equal to  $\frac{S}{4} + \sqrt{\frac{SS}{4} - R}$ , and here the Root  $a$  hath two real Values; make  $CT (= \frac{1}{2}S)$  the Radius of a Circle, and erect the



Perpendicular  $ET = \sqrt{R}$ ; then draw  $EQ$  Parallel to  $CT$ , and  $NO$  Parallel to  $ET$ , draw also the Radius  $CN$ . Then will (by

$$47. e. 1. Euclid.) CO = \sqrt{\frac{SS}{4} - R}, \text{ and}$$

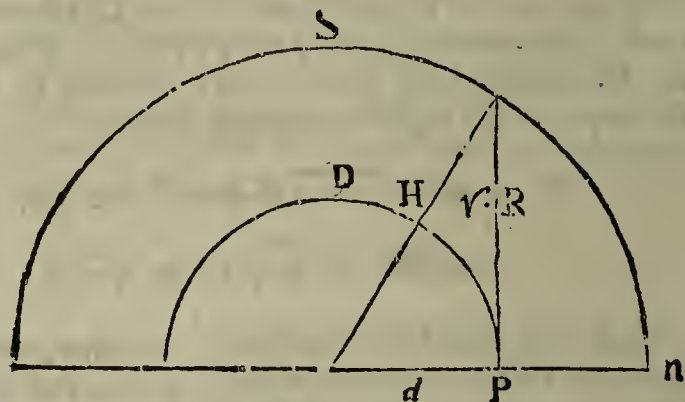
$$\text{consequently, } BO = \frac{S}{2} + \sqrt{\frac{SS}{4} - R} =$$

the greater Root  $a$ , and  $OT = \frac{S}{2} - \sqrt{\frac{SS}{4} - R}$ .

Or the two Roots will be  $QN$ , and  $NE$ ; equal to the two former.

Dr. Wallis's Way of Constructing the Three Forms of all Quadratick Equations, according to Mr. Oughtred's Method of Solution.

Draw two Concentrick Circles, and let the Diameter of the greater be called  $S$ , and the Diameter of the lesser  $D$ , the Sum and Difference of the Roots found. Wherefore  $H$  and  $d$  will represent the half Sum and half Difference of the Roots.



Since therefore Oughtred's Theorem, as is shew- ed above, is, That  $SS - DD = 4R$ . Where-  $SS - DD = R$

fore, : divide all by 4 :  $\frac{SS - DD}{4} = R$ . Let

$VR$  be made a Tangent to the lesser, or a Right- Sine to the greater Circle, as you see in the Figure according as  $D$ , or  $S$ , is given : And draw also the Hypothenufe  $H$ . Then will the Base of the Tri- angle be  $d$ . And  $HH - dd = R$  (by 47. e. 1.)  $SS - DD$

That is,  $\frac{SS - DD}{4} = R$ . Wherefore by Trans- position,  $HH = R + dd$ , and therefore  $H =$

$\sqrt{R + dd}$ . And consequently, if it had been in the first or second Forms, where  $d$  and  $R$  were given,  $H$  will also be found. Or if  $H$  had been given, and  $d$  required as in the third Form, since,  $HH = R + dd$ : Therefore,  $HH - R = dd$ ; And  $\sqrt{HH - R} = d$ : And having thus found  $A$  and  $d$ , the  $\frac{1}{2}$  Sum and  $\frac{1}{2}$  Difference of the two Roots: Then  $H + d (= op)$  will be the great- er Root  $a$ , and  $H - d (= pn)$  will be the lesser, which will be Affirmative or Negative, according to the Form and Circumstances of the Equation.

A Question and Problems in Affected Quadratick Equations.

### QUESTION.

Two Men have each a certain Number of Crowns, whose Sum Subtracted from the Sum of their Squares, leaves  $R = 78$ : But their Sum added to the Product of the two Numbers, makes  $39 = S$ . How many Crowns had each?

For the unknown Sum of the Numbers put  $2a$ . And for their Difference  $2e$ .

For then the Numbers may be thus noted,  $a + e =$  the greater, and  $a - e =$  the lesser.

Then



Then,

|                 |    |  |
|-----------------|----|--|
|                 | I  | $2aa + 2ee =$ Sum of their Sq.   |
| $1 - 2a$        | 2  | $2aa + 2ee - 2a = R.$ by the State of the Question.                    |
| $2 \div 2$      | 3  | $aa + ee - a = \frac{R}{2} \cdot 39 = S.$                              |
| by Transp.      | 4  | $39 - aa + a = ee$ which Step will at last help to find $e.$           |
| $\square + 2a$  | 5  | $aa - ee + 2a = S.$ Their Product added to their Sum.                  |
| by Transp.      | 6  | $aa + 2a - S = ee.$  |
| 4, 6,           | 7  | $39 - aa + aa = aa + 2a - 39 (S) = ee.$                                |
| by Transp.      | 8  | $78 = 2aa + a.$  |
| Comp. $\square$ | 9  | $aa + \frac{1}{2}a = 39 = S,$ which is a Quadratick of the first Form. |
| $w$             | 10 | $aa + \frac{1}{2}a + \frac{1}{18} = 39 + \frac{1}{18}.$                |
|                 | 11 | $a + \frac{1}{4} = \sqrt{39 + \frac{1}{18}}.$                          |
|                 | 12 | $a = \sqrt{39 + \frac{1}{18}} - \frac{1}{4} = 6.$                      |
|                 | 13 | Therefore $2a = 12.$   |

And ( $a$ ) being known, the value of ( $e$ ) will be found from the fourth Step. Where  $e = 3.$

Now by our Supposition at first, the greater Number was  $a + e$ , that is 9; and the lesser was  $a - e$ ; that is 3: Which numbers 3 and 9, will answer the Question.

For 12 their Sum, taken from 90, the Sum of their Squares, leaves 78; and added to 27, their Rectangle, makes 39.

N. B. By this Method of putting  $a + e$  and  $a - e$  for the two Numbers sought, instead of  $a$  and  $e$  as in the Common way; many Questions producing Affected Quadratick Equations, when that way managed, may be solved as easily, and in the manner of Simple Equations. Especially when the Sum and Difference, or Sum or Difference of the Squares of the Quantities sought, are among the Data.

### PROBLEM I.

The Difference of both the Legs of a Right angled Triangle being given from the Hypotenuse; to find the Sides severally; and to form the Triangle.

Let the Difference of the lesser Side from the Hypotenuse be ( $b$ ) and that of the greater ( $d$ )

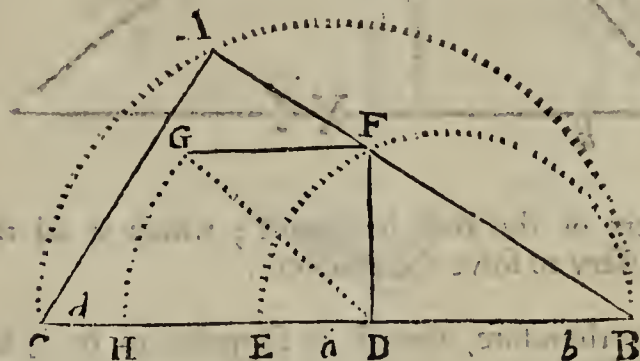
For the greater Side sought put ( $a$ )

Then will,

|                 |   |  |
|-----------------|---|--|
|                 | 1 | $a + d =$ Hypotenuse, and  |
| $1 - b$         | 2 | $a + d - b =$ to the lesser Side.  |
| 47. e. 1.       | 3 | $aa + 2ad + dd = 2aa + 2ad - 2ab - 2bd + dd + bb.$                           |
|                 | 4 | $aa - 2ab - 2bd + bb = 0.$ by Comparison and Transposition of the last Step. |
| Transp.         | 5 | $aa - 2ab = 2bd - bb.$ which is a Quadratick Equation of the Second Form.    |
| Comp. $\square$ | 6 | $aa - 2ab + bb = 2bd.$   |
| $w$             | 7 | $a - b + \sqrt{2bd} = a.$  |
|                 | 8 | $a = \sqrt{2bd} + b.$  |

### Geometrical Construction

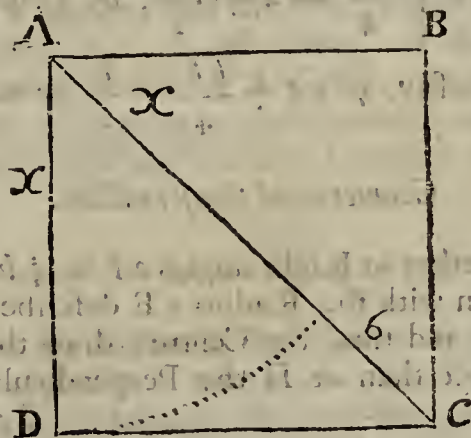
Find a mean proportional between  $d$  and  $b$ , which let be  $DF$ : to which, place at Right-angles  $FG =$  to  $DF$ , Draw  $GD$ , and cut off  $HD = GD$ . Then will  $BH$ , be the greater Side sought. And this being



produced to C (so that  $CH = ED$ ) will give  $CD (= AC)$  the lesser Side of the Triangle required; for  $a + d - b =$  lesser Side; Draw a Semi-circle on  $CB$  and apply  $AB = HB$ . Then draw  $AC$ , and the Triangle is found, which is  $ACB$ .

### PROBLEM II.

Having in the Square  $ABCD$ , the Difference between the Sides and Diagonal  $= 6$ , or  $a$ , to find the Side of the Square.



Let the Side sought be called  $x$ , and  $6 = a$ :

Then  $x + a = AC$  the Diagonal.

But (by 47. e. 1 Euc.)  $AC^2 = 2AD^2$ ; or to  $2xx$ .

That is  $xx + 2xa + aa = 2xx$ .

Expunge then  $xx$  on both Sides, and it will be

$2xa + aa = xx$ , and then by Transposition,

$xx + 2ax - aa = 0.$  Compleat the Square, and it will be  $xx - 2ax + aa = 2aa.$

Wherefore  $x - a = \sqrt{2aa},$

And consequently  $x = \sqrt{2aa} + a = 14.48.$

### PROBLEM III.

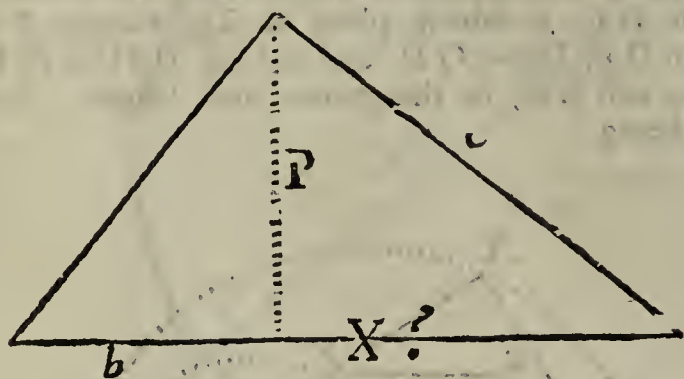
Given one Segment of the Base of a Right-angled Triangle, as also the Side of the Triangle Adjacent to the other Segment of the Base; 'tis required to find the rest, and to form the Triangle.

3 X x

Suppose



Suppose it done ; and let the Segment  $b$ , and the Side  $c$ , be both known or given. Let  $x$ , the other



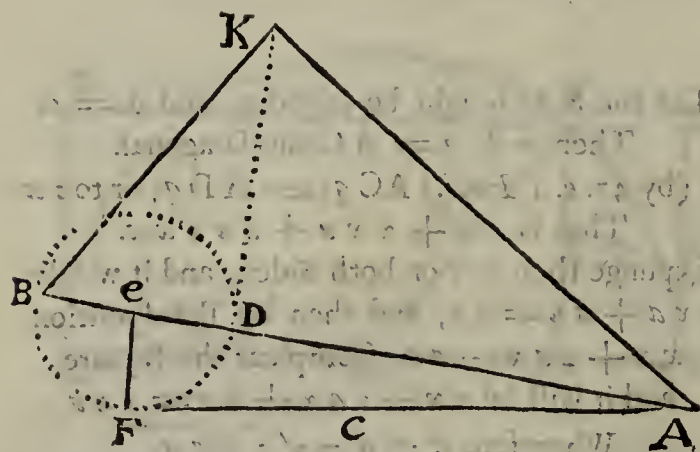
Segment of the Base be sought ; which is all that is necessary to solve the Problem.

Here therefore, since  $P$  is supposed to be a true Perpendicular ;

- 1  $cc + xx = pp$ . 47<sup>e</sup> Euclid.
- 2 And because the Angle at the Top is a Right one, therefore  $pp = bx$ , which gives another way of expressing  $pp$ . So that,
- 3  $cc - xx = bx$ , and consequently by Transposition,
- 4  $cc = xx + bx$ . which is an Affected Quadratick of the first Form. Wherefore,
- 5  $cc + \frac{bb}{4} = xx + bx + \frac{bb}{4}$  by completing the Square. And,
- 6  $\sqrt{cc + \frac{bb}{4}} = x + \frac{b}{2}$ , by Evolution,
- 7 Lastly,  $\sqrt{cc + \frac{bb}{4}} - \frac{b}{2} = x$ .

*Geometrical Construction.*

Join together at Right-angles  $eE - \frac{1}{2}b$  and  $EA = C$ , Then with the Radius  $eE$  describe the Circle  $BED$ , and thro' the Centre  $e$  draw the Line  $AD$ . Erect then at  $D$  the Perpendicular  $DK$ ,



which Limit, by describing a Semi-circle on  $BA$ , that Semi-circle shall cut the Perpendicular in the Point  $K$ , the Vertex of the Triangle required, whence draw the two Legs  $BK$  and  $KA$ . So is  $BKA$  the Triangle sought.

QUADRATRIX (in Geometry) is a Curve Line thus generated.



Let there be a Radius of a Circle, as  $AD$ , which imagine to move on the Centre  $A$  down the Circumference of the Quadrant  $DB$ , and at the same time, let the Side of the Square  $CD$  move equally downwards, so that the Radius  $AD$  and the Side of the Square  $CD$ , may come to the Line  $AB$  together. Or let the Right Line  $DA$ , and the Quadrantal Ark  $DB$ , be both divided into a like Number of equal Parts, as in this Case they are each into 8. And to the Divisions of the Quadrant let as many Radii be drawn from the Centre  $A$ , and thro' the Divisions in  $AD$  as many Parallels to  $CD$ ; for then if a Curve Line be drawn neatly connecting the Points of Intersection of these Radii and Parallels, it will be that Line which is called the *Quadratrix* (as  $DE$ ). From this Genesis of the Quadratrix arise these Corollaries.

1. That if through any Point, as  $H$  in this Quadratrix, you draw a Radius  $AHI$ , and the two Perpendiculars  $Hb$  and  $He$ , it will be, as the whole Quadrantal Ark  $DB$ , is to the part  $IB ::$  so will the whole right Line  $DA$  be to the part of it cut off  $bA$ , or its equal  $He$ , as is plain from considering the equal motion of the Radius  $AD$ , and the side of the Square  $DC$ , which intersect each other in  $H$ .

2. Wherefore any Ark of the Quadrant as  $IB$ , or any Angle as  $IAB$ , may by this Quadratrix be easily divided into 3 equal parts, or any other Number at Pleasure, or according to any given Ratio, by only drawing the Radius  $AI$ , and then from the point of the Quadratrix  $H$  letting fall the Perpendicular  $He$ : for if  $He$  be divided into 3 or any given Number of equal parts, Lines drawn from  $A$  the Centre through those Divisions shall divide the Ark or Angle after the same manner. For as the parts of  $He$  are to the whole Line :: so will the parts of the Ark  $IB$  be to the whole Ark: By the former Corollary,

3. I say, That the Base of the Quadratrix  $AE$  is a third Proportional to the Radius  $AD$ , and the Quadrant  $DB$ .

For  $DB : DA :: IB : He$ , as follows (alternately) from Cor. 1.

And  $IB : He :: bA : eA$ , by the Triangles being Similar.

Now if you conceive the Ark  $IB$  to grow infinitely small, it must at last come to the same as its right Sine  $Ib$ , and both will coincide in the point  $B$ ; and at the same time as  $HE$  and  $He$  coincide in the point  $E$ , (by the Genesis of the Curve;) so that at last  $Ae$  and  $AE$ ,  $Ab$  and  $AB$  will be coincident: And therefore at last  $DB : DA :: IB$

(i. e.  $Ib$ )



(i. e. I b) H e. That is, as A b. A e. or which is the same at last, as A B (or A D) to A E.

Wherefore D B. D A :: D A. A E. Q. E. D.

4. Wherefore if on the Base of the Quadratrix A E, a Quadrantal Ark be described, it will be equal in Length to D A the Side of the Square: And consequently the Semicircle will be double, and the Periphery Quadruple of D A.

5. Hence may a Right Line be found equal to D B or any other Quadrant of a Circle, by only making as A E. A D :: A D to a Third Proportional, which will be equal to the Quadrantal Ark, by Cor. 3.

6. After the same manner may a Right Line be found equal to I B, or any other Ark of a Circle less than a Quadrant, if it be made as D A. H e :: D B. D B to a fourth Proportional by Cor. 1.

7. So that the Quadrature of the Circle, and the Trisection of an Angle might Geometrically be effected, if this *Quadratrix* were a true Geometrical Curve, as indeed it is not.

QUADRATO QUADRATUM, is the fourth Power of Numbers; or the product of the Cube multiplied by its Root; a *Biquadrate*.

QUADRATO CUBUS, the fifth Power of Numbers.

QUADRATO Quadrato Cubus, the seventh Power of Numbers.

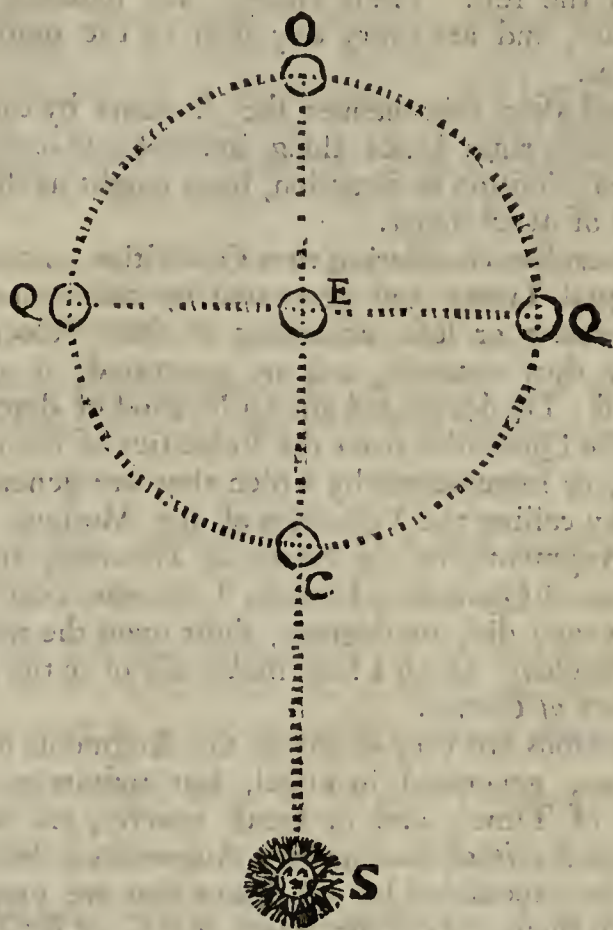
QUADRATO Cubo Cubus, the eighth Power of Numbers.

QUADRATRIX of the *Hyperbola*: There is a new Curve lately invented by Mr. J. Perks of Great Swinford in Worcester-shire, for the Quadrature of the Hyperbola; of which see an Account in *Phil. Trans.* N. 306.

QUADRATURE of any Figure in Mathematics, is the finding a Square equal to the Area of it. See *Lunes*.

QUADRATURE of the *Parabola*. See *Parabolick Space*.

QUADRATURES of the Moon, are the Middle Points of her Orbit, between the Points of Conjunction and Opposition: And they are so called, because a Line drawn from the Earth to the Moon, is then at Right Angles, with one drawn from the Earth to the Sun. When the Moon having been either in Conjunction with the Sun, at C, or in Opposition to him at O, is come to Q, then she is in the Quadratures.



QUADRATURE Lines, or Lines of Quadrature; are two Lines placed usually, or at least sometimes, on Mr. Gunter's Sector, and easily known there, by being marked with the Letter Q, and the Figures 5, 6, 7, 8, 9, 10; of which Q signifies the side of a Square, and the other Figures the sides of Polygons of 5, 6, 7, &c. sides, S. there stands for the Semi-diameter of a Circle, and 90 for a Line equal to 90 degrees in the Circumference.

Their Uses are readily (though not exactly) these:

1. To make a Square equal to a given Circle.

Open the Sector to the Radius of the given Circle by applying it over in the point S, S, and then the parallel Distance between the points Q. Q. is the side of the Square required.

2. To make a Circle equal to a given Square.

Apply the side of the Square over in Q. Q. so will the parallel Distance between S, S. be the Radius of the Circle sought.

3. To reduce a Square, or a Circle, into a Pentagon, or other regular Polygon equal to it.

Take the side of the Square, or Radius of the Circle given, and apply it over in its proper points and then the Parallel Distances between the points of any of the other Polygons, shall be the sides of those Regular Figures.

QUADRATURE of Curves, by Sir Is. Newton.

I don't here consider Mathematical Quantities as composed of Parts *extreamly small*, but as generated by a continual Motion. Lines are described, and by describing are generated, not by any apposition of Parts, but by a continual Motion of Points. Surfaces are generated by the motion of Lines, Solids

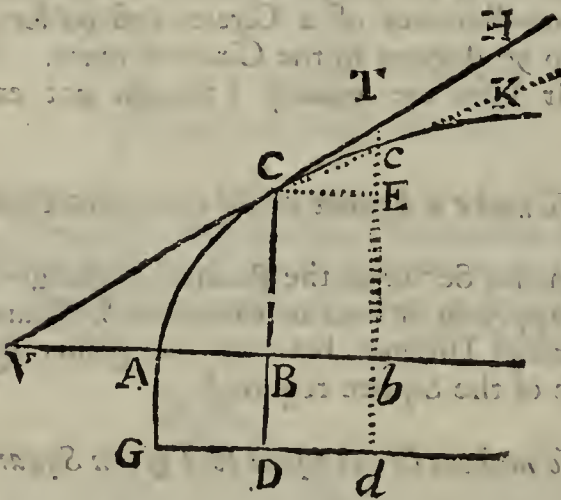


lids by the motion of Surfaces, Angles by the Rotation of their Legs, Time by a continual Flux, and so in the rest. These *Geneses* are founded upon Nature, and are every day seen in the motion of Bodies.

And after this manner the Antients by carrying moveable right Lines along immoveable ones in a normal Position or Situation, have taught us the *Geneses* of Rectangles.

Therefore considering that Quantities, encreasing, in equal Times, and generated by this encreasing, are greater or less, according as their Velocity by which they encrease, and are generated, is greater or less: I endeavoured after a Method of determining the Quantities from the Velocities of their Motions, or Increments, by which they are generated; and by calling the Velocities of the Motions, or of the Augments, by the Name of *Fluxions*, and the generated Quantities *Fluents*, I (in the Year 1665 and 1666) did, by degrees, light upon the method of *Fluxions*, which I here make use of in the *Quadrature of Curves*.

Fluxions are very nearly as the Augments of the Fluents, generated in equal, but infinitely small parts of Time; and to speak exactly, are in the *Prime Ratio* of the nascent Augments; but they may be expounded by any Lines that are proportional to them. As if the *Areas*  $ABC$ ,  $ABD$  be described by the Ordinates  $BC$ ,  $BD$ , moving with an uniform Motion along the Base  $AB$ , the Fluxions of these *Areas* will be to one another as the describent Ordinates  $BC$  and  $BD$ , and may be expounded by those Ordinates; for those Ordinates are in the same proportion as the nascent Augments of the *Areas*.



Let the Ordinate  $BC$  move out of its place  $BC$  into any new one  $bc$ : Compleat the Parallelogram  $BCEb$ , and let the right Line  $VTH$  be drawn which may touch the Curve  $C$ , and meet  $bc$  and  $BA$  produced in  $T$  and  $V$ ; and then the just now generated Augments of the Abscissa  $AB$ , the Ordinate  $BC$ , and the Curve Line  $ACc$ , will be  $Bb$ ,  $Ee$ , and  $Cc$ ; and the sides of the Triangle  $CET$ , are in the *Prime Ratio* of these nascent Augments, and therefore the Fluxions of  $AB$ ,  $BC$  and  $AC$  are as the sides  $CE$ ,  $ET$ , and  $CT$  of the Triangle  $CET$ , and may be expounded by those sides, or, which is much at one, by the sides of the Triangle  $VBC$  similar to it.

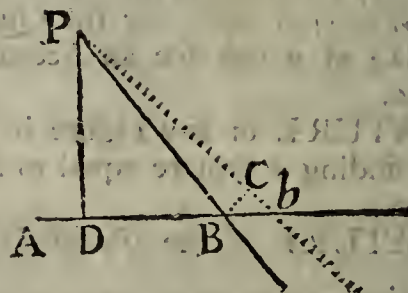
'Tis the same thing if the Fluxions be taken in the *ultimate Ratio* of the evanescent Parts. Draw the Right Line  $Cc$ , and produce the same to  $K$ . Let the Ordinate  $bc$  return into its former place  $BC$ , and the points  $C$  and  $c$  coming together, the

Right Line  $CK$  co-incides with the Tangent  $CH$ , and the evanescent Triangle  $C'Ec$  in its ultimate Form becomes similar to the Triangle  $CET$ , and its evanescent Sides  $CE$ ,  $Ee$  and  $Cc$  will be ultimately to one another as are  $CE$ ,  $ET$  and  $CT$  the sides of the other Triangle  $CET$ , and therefore the Fluxions of the Lines  $AB$ ,  $BC$  and  $AC$  are in the same *Ratio*. If the points  $C$  and  $c$  be at any small distance from one another, then will  $CK$  be at a small distance from the Tangent  $CH$ . As soon as the right Line  $K$  co-incides with the Tangent  $CH$ , and the ultimate Ratios of the Lines  $CE$ ,  $Ee$  and  $Cc$  be found, the Points  $C$  and  $c$  ought to come together and exactly to co-incide. For Errors tho' never so small, are not to be neglected in Mathematicks.

By the same way of arguing, if a Circle described on the Centre  $B$  with the Radius  $BC$ , be drawn with an uniform Motion along the Abscissa  $AB$ ; and at right Angles to it, the Fluxion of the generated Solid  $ABC$  will be as the generating Circle; and the Fluxion of its Surface will be as the Perimeter of that Circle and the Fluxion of the Curve Line  $AC$  conjointly. For in what Time the Solid  $ABC$  is generated by drawing the Circle along the Abscissa  $AB$ , in the same Time its Surface is generated by drawing the Perimeter of that Circle along the Curve  $AC$ .

Of this Method take the following Examples.

Let the Right Line  $PB$  revolving about the given Pole  $P$  cut the Right Line  $AB$  given in Position; the Proportions of the Fluxions of the Right Line  $AB$  and  $PB$  is required.

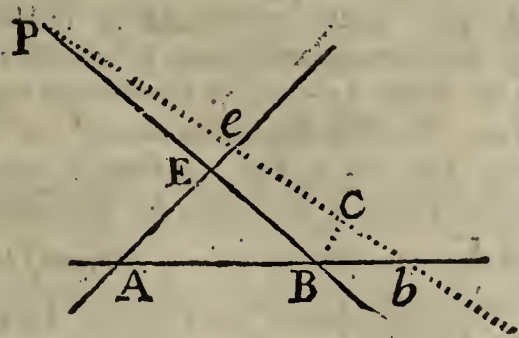


Let the Right Line  $PB$  go out of its place  $PB$  into a new one  $Pb$ : In the Line  $Pb$  take  $Pc$  equal to  $Pb$ , and draw  $PD$  to  $AB$  so that the Angle  $bPD$  may be equal to the Angle  $bPC$ ; and then from the Similarity of the Triangles  $bBC$ ,  $bPD$ , the Augment  $Bb$ , will be to the Augment  $Cb$  as  $Pb$  is to  $Db$ .

Now let  $Pb$  return into its former place  $PB$ , that those Augments may vanish, and the ultimate Ratio of the evanescent Augments, that is, the ultimate Ratio of  $Pb$  to  $Db$  will be the same as that of  $PB$  to  $DB$ , the Angle being right; and therefore the Fluxion of  $AB$  is to the Fluxion of  $PB$  in this Ratio.

Let the Right Line  $PB$  revolving about the given  $P$  Pole cut  $AB$  and  $AE$  two other Right Lines given in Position in  $B$  and  $E$ ; 'tis required to find the Proportion of the Fluxions of those Right Lines  $AB$  and  $AE$ .





Let the revolving Line  $PB$  move out of its place  $PB$  into a new one  $Pb$ , cutting  $AB$ ,  $AE$  into the Points  $b$  and  $E$ , and draw  $BC$  parallel to  $AE$ , meeting  $Pb$  in  $C$ ; then  $Bb$  will be to  $BC$  as  $Ab$  is to  $Ae$ ; and  $BC$  to  $Ee$  as  $Ab \times PB$ , to  $Ae \times PE$ . Now let the Right Line  $Pb$  return into its former place  $PB$ , and the Evanescent Augment  $Bb$  will be to the Evanescent Augment  $Ee$  as  $AB \times PB$  is to  $AE \times PE$ , and therefore, in this Ratio is the Fluxion of the Right Line  $AB$  to the Fluxion of the Right Line  $AE$ .

Hence if the revolving Right Line  $PB$  cut any Curve Lines given in position in the Points  $B$  and  $E$ , and the moveable Right Lines  $AB$ ,  $AE$  touch those Curves in  $B$  and  $E$ , the Points of Section; the Fluxion of the Curve which the Right Line  $AB$  touches, will be to the Fluxion of the Curve which the Right Line  $AE$  touches, as  $AB \times PB$  is to  $AE \times PE$ . The same Thing will happen if the Right Line  $PB$  always touch any Curve given in position in the moveable Point  $P$ .

Let the Quantity  $x$  flow uniformly, and let the Fluxion of  $x^n$  be to be found. In the same time that the Quantity  $x$  by flowing becomes  $x + o$ , the Quantity  $x^n$  will become  $x^n + o|n$ , that is, by the Method of Infinite Series's  $x^n + no x^{n-1} + \frac{n \cdot n-1}{2} o^2 x^{n-2} + \text{Ec}$ . and the Augments  $o$  and  $no x^{n-1} + \frac{n \cdot n-1}{2} o^2 x^{n-2} + \text{Ec}$ . are to one another as 1 and  $n x^{n-1} + \frac{n \cdot n-1}{2} o x^{n-2} + \text{Ec}$ . Now let those

Augments vanish, and their ultimate Ratio, will be the Ratio of 1 to  $n x^{n-1}$ ; and therefore the Fluxion of the Quantity  $x$  is to the Fluxion of the Quantity  $x^n$  as 1 to  $n x^{n-1}$ .

By like ways of arguing, and by the Method of prime and ultimate Ratio's, may be gathered the Fluxions of Lines, whether Right or Crooked in all Cases whatsoever, as also the Fluxions of Surfaces, Angles, and other Quantities. In Finite Quantities so to frame a Calculus, and thus to investigate the prime and ultimate Ratios of Nascent or Evanescent Finite Quantities, is agreeable to the Geometry of the Ancients; and I was willing to shew, that in the Method of Fluxions there's no need of introducing Figures infinitely small into Geometry. For this Analysis may be performed in any Figures whatsoever, whether finite or infinitely small, so they are but imagined to be similar to the Evanescent Figures; as also in Figures which may be reckoned as infinitely small, if you do but proceed cautiously.

From the Fluxions to find the Fluents is the more difficult Problem, and the 1st step of the Solution of it is equivalent to the Quadrature of Curves; concerning which I have formerly written the following Tract.

# A Treatise of the Quadrature of Curves.

I consider indetermin'd Quantities as encreasing or decreasing by a perpetual Motion, that is, as flowing encreasingly or decreasingly; and I represent them by the Letters  $z, y, x, v$ , and I mark their Fluxions or their Celerities by which they encrease by the same Letters with Points over them

thus,  $\dot{z}, \dot{y}, \dot{x}, \dot{v}$ . There are likewise Fluxions of Fluxions, or Mutations more or less swift, which may be called the Second Fluxions of  $z, y, x, v$ , and may be marked thus,  $\ddot{z}, \ddot{y}, \ddot{x}, \ddot{v}$ ; and the First Fluxions of these, or the Third Fluxions of  $z, y, x, v$ , thus,  $\dddot{z}, \dddot{y}, \dddot{x}, \dddot{v}$ ; the Fourth thus,  $\ddddot{z}, \ddddot{y}, \ddddot{x}, \ddddot{v}$ , &c. And as  $z, y, x, v$ , are Fluxions of the Quantities  $z, y, x, v$ , and these are Fluxions of the Quantities  $z, y, x, v$ , and these Fluxions of the Quantities  $z, y, x, v$ : So these Quantities may be considered as Fluxions of others,

which I shall mark thus,  $\dot{z}, \dot{y}, \dot{x}, \dot{v}$ ; and these as Fluxions of others  $z, y, x, v$ , and these as Fluxions of others  $\dot{z}, \dot{y}, \dot{x}, \dot{v}$ . Wherefore  $z, \dot{z}, \ddot{z}, \dddot{z}, \dddot{z}, \dddot{z}, \text{Ec}$ . represent a Series of Quantities, in which every subsequent one is the Fluxion of the precedent, and any preceding one is a flowing Quantity or a Fluënt, which has for its Fluxion that which follows it.

Of the like Nature is this Series  $\sqrt{az-zz}, \sqrt{az-zz}, \sqrt{az-zz}, \sqrt{az-zz}, \sqrt{az-zz};$  as also this Series,  $\frac{az+z^2}{a-z}, \frac{az+z^2}{a-z}, \frac{az+z^2}{a-z}, \frac{az+z^2}{a-z}, \frac{az+z^2}{a-z}, \frac{az+z^2}{a-z}, \text{Ec}$ .

And it is to be observed, that any preceding Quantity in these Series's is as the Area of a Curvilinear Figure, whose Ordinate Applicata apply'd at Right Angles is the flowing Quantity; and

its Abscissa  $z$ : as  $\sqrt{az-zz}$  is the Area of a Curve whose Ordinate Applicata is  $\sqrt{az-zz}$ , and the Abscissa  $z$ .

The Design of all this will be apparent from the following Propositions.

Prop. I. Prob. I.

Having given an Equation involving any Number of fluent or flowing Quantities, to find their Fluxions.

Solution.

Multiply every Term of the Equation by the Index of the Power of each flowing Quantity contained in that Term, and in each Multiplication change the Root of the Power into its Fluxion; and then the Aggregate of all the Products under their proper Signs will be the new Equation.



*Explication.*

Let  $a, b, c, d$ , &c. be determined, and immutable Quantities, and let any Equation be proposed, containing the fluid or flowing Quantities  $z, y, x$ , &c. as  $x^3 - xyy + aaz - b^3 = 0$ . First let the Terms be multiply'd by the Indexes of the Powers of  $x$ , and in each Multiplication, instead of the Root or Side of the Power, or instead of  $x$  of one Dimension only, write  $\dot{x}$ , and the Summ of the Products will be  $3xx\dot{x} - xyy$ . Let the same be done by  $y$ , and you will have  $-2xy\dot{y}$ : Do the same by  $z$ , and there will be produced  $aaz$ . Let the Sum of the Products be put equal to 0 and you will have the Equation  $3xx\dot{x} - xyy - 2xy\dot{y} + aaz = 0$ ; I say that in this Equation the Relation of the Fluxions is determined.

*Demonstration.*

For let  $o$  be a Quantity extremely small, and let  $oz, oy, ox$ , be the Moments of the Quantities  $z, y, x$ ; that is, the momentaneous synchronical Increments. And if the flowing Quantities are now  $z, y$ , and  $x$ , these after a Moment of Time being augmented by their Increments  $oz, oy, ox$ , will become  $z + oz, y + oy, x + ox$ , which being substituted in the first Equation instead of  $z, y$ , and  $x$ , give this Equation,  $x^3 + 3xxox + 3xcoxx + o^3x^3 - xyy - oxyy - 2xoyy - 2xcoyy - xcoyy - xco^3yy + aaz + aacz - b^3 = 0$ . Subtract the former Equation from it and the Residual divided by  $o$  will be  $3xx\dot{x} + 3xxox + x^3oo - xyy - 2xyy - 2xoyy - xoyy - xcoyy + aaz = 0$ . Let the Quantity  $o$  be lessened infinitely, and neglecting the evanescent Terms, there will remain  $3xx\dot{x} - xyy - 2xy\dot{y} + aaz = 0$ . Q. E. D.

*A more full Explication of the same Thing.*

After the same Manner, if the Equation were  $x^3 - xyy + aa\sqrt{ax - yy} - b^3 = 0$ , there would be produced  $3x^2\dot{x} - xyy - 2xy\dot{y} + aa\sqrt{ax - yy} = 0$ ; where, if you would take away the Fluxion

$\sqrt{ax - yy}$ , put  $\sqrt{ax - yy} = z$ , and then will  $ax - yy = z^2$ , and (by this Proposition)  $ax - 2yy = 2z\dot{z}$  or  $\frac{ax - 2yy}{2z} = \dot{z}$ , that is,  $\frac{ax - 2yy}{2\sqrt{ax - yy}} = \sqrt{ax - yy}$ :

And thence  $3x^2\dot{x} - xyy - 2xy\dot{y} + \frac{a^3x - 2aayy}{2\sqrt{ax - yy}} = 0$ .

And by the same Operation, you may proceed to second Fluxions, Third Fluxions, and so on: Let the Equation  $zy^3 - z^4 + a^4 = 0$ , then it will be made by the first Operation,  $zy^3 + 3zy\dot{y}^2 - 4z^3\dot{z} = 0$ , by the Second Operation  $zy^3 + 6zy\dot{y}^2 + 3zy\dot{y}^2 + 6z\dot{y}^2\dot{y} - 4z^2\dot{z}^2 - 12z^2\dot{z}\dot{z} = 0$ ; and by the Third,  $zy^3 + 9zy\dot{y}^2 + 9z\dot{y}^2\dot{y} + 18z\dot{y}^2\dot{y} + 3z\dot{y}^2\dot{y} + 18z\dot{y}\dot{y}\dot{y} + 6z\dot{y}^3 - 4z^2\dot{z}^2 - 36z\dot{z}\dot{z}^2 - 24z^2\dot{z}\dot{z} = 0$ .

But when we thus proceed to Second and Third Fluxions, &c. it is convenient to consider some Quantity as flowing uniformly; and for its first Fluxion to write 1; but for the second and following ones 0. Let the Equation be  $zy^3 - z^4 + a^4 = 0$ , as above; and let  $z$  flow uniformly, and let its Fluxion be Unity; and then by the first Operation it will become  $y^3 + 3zy\dot{y}^2 - 4z^3 = 0$ , by the Second  $6zy\dot{y}^2 + 3zy\dot{y}^2 + 6z\dot{y}^2\dot{y} - 12z^2 = 0$ , by the Third  $9zy\dot{y}^2 + 18\dot{y}^2\dot{y} + 3zy\dot{y}^2 + 18z\dot{y}\dot{y}\dot{y} + 6z\dot{y}^3 - 24z = 0$ .

But in Equations of this kind we must conceive, that the Fluxions in each of the Terms are of the same Order, that is, that they are all either of the first Order  $\dot{y}, \dot{z}$ , or all of the second  $\ddot{y}, \ddot{z}, \dot{y}\dot{z}, \dot{z}^2$ , or all of the third,  $\ddot{y}, \ddot{y}\dot{y}, \ddot{y}\dot{z}, \ddot{y}^2, \ddot{y}\dot{z}^2, \dot{z}^3$ , &c. And when the Thing happens otherwise, the Order is to be compleated by the supposed Fluxions of a Quantity flowing uniformly; and then the last Equation, by compleating the third Order, becomes  $9zy\dot{y}^2 + 18z\dot{y}^2\dot{y} + 3zy\dot{y}^2 + 18z\dot{y}\dot{y}\dot{y} + 6z\dot{y}^3 - 24z^3 = 0$ .

*Prop. 2. Prob. 2.*

*To find the Curves that are Quadrable.*

Let  $ABC$  be the Figure, whose Area is to be found;  $BC$  an Ordinate apply'd at Right Angles, and  $AB$  the Abscissa. Produce  $CB$  to  $E$  that  $BE$  may be  $= 1$ , and compleat the Parallelogram  $ABED$ ; and the Fluxions of the Areas  $ABC, ABED$  will be as  $BC$  and  $BE$ : Therefore take any Equation by which the Relation of the Areas may be determined, and thence will be given the relation of the Ordinates  $BC$  and  $BE$ , (by Proposition 1.) Q. E. D.

We shall give Examples of this Thing in the two following Propositions.

*Prop. 3. Theor. 1.*

If  $z$  be used promiscuously for the Abscissa  $AB$  and the Area  $AE$  or  $AB \times z$ ; and  $R$  be put for  $E + fzn + gz^2n + hz^3n$ , &c. Let the Area of the Curve be  $Z\theta R^\lambda$ , and the Ordinate Applicate  $BC$  will be  $= \theta E^{\frac{1}{\lambda-1}} f^{\frac{\theta}{\lambda-1}} z^{\frac{\theta}{\lambda-1}} + 2\lambda n g z^{\frac{\theta}{\lambda-1}} + 3\lambda n h z^{\frac{\theta}{\lambda-1}} + \text{Ec.}$  into  $z^{\theta-1} R^{\lambda-1}$ .

*Demonstration.*

For if  $z^\theta R^\lambda = v$ , then by the first Prop. will  $\theta z^{\theta-1} R^\lambda + \lambda z^\theta R^{\lambda-1} \dot{R} = \dot{v}$ . Instead of  $R^\lambda$  in the first term of the Equation, and  $z^\theta$  in the second, write  $R R^{\lambda-1}$  and  $z^{\theta-1}$ , and then the Equation will become  $\theta z R + \lambda z R$  into  $z^{\theta-1} R^{\lambda-1} \dot{v}$ . But  $R$  was taken equal to  $E + fzn + gz^2n + hz^3n$ , &c. and consequently (by Prop. 1.)  $R = n f z^{\lambda-1} + 2n g z^{\lambda-1} + 3n h z^{\lambda-1} + \text{Ec.}$  which being substituted in their stead, and  $BE$  or 1 placed in the room of  $z$ ; Then



then will  $\theta z^{\frac{\theta}{\lambda} + 1} + f z^{\frac{\theta}{\lambda} + 2} + g z^{\frac{\theta}{\lambda} + 3} + h z^{\frac{\theta}{\lambda} + 4} + \dots$   
 &c. into  $z^{\theta-1} R^{\lambda-1}$  be  $= v = B C$ . Q. E. D.

Prop. 4. Theor. 2.

If for the Abscissa  $AB$  be put  $z$ , for  $e + f z^{\frac{\theta}{\lambda}} + g z^{\frac{\theta}{\lambda} + 2} + \dots$  &c. be put  $R$ , and  $S$  for  $k + l z^{\frac{\theta}{\lambda}} + m z^{\frac{\theta}{\lambda} + 2} + \dots$  &c. Let the Area of the Curve be  $z^{\theta} R^{\lambda} S^{\mu}$ ; then the Ordinate Applicate  $BC$  will be =

$$\left. \begin{array}{l} \theta k + \frac{\theta}{\lambda} f k z^{\frac{\theta}{\lambda}} + \frac{\theta}{2\lambda} g k z^{\frac{\theta}{\lambda} + 2} + \dots \\ + \theta e l z^{\frac{\theta}{\lambda}} + \frac{\theta}{\lambda} f l z^{\frac{\theta}{\lambda} + 2} + \frac{\theta}{2\lambda} g l z^{\frac{\theta}{\lambda} + 4} + \dots \\ + \mu n \\ + \frac{\theta}{2\mu} e m z^{\frac{\theta}{\lambda}} + \frac{\theta}{\lambda} f m z^{\frac{\theta}{\lambda} + 2} + \frac{\theta}{2\lambda} g m z^{\frac{\theta}{\lambda} + 4} + \dots \end{array} \right\} \begin{array}{l} \text{into} \\ z^{\theta-1} \\ R^{\lambda-1} \\ S^{\mu-1} \end{array}$$

This is demonstrated after the same Manner as the former Proposition.

Prop. 5. Theor. 3.

If  $z$  be put for the Abscissa of the Curve  $AB$ , and  $R$  be put for  $e + f z^{\frac{\theta}{\lambda}} + g z^{\frac{\theta}{\lambda} + 2} + h z^{\frac{\theta}{\lambda} + 4} + \dots$  &c. And let the Ordinate Applicate be  $z^{\theta-1} R^{\lambda-1}$  multiply'd into  $a + b z^{\frac{\theta}{\lambda}} + c z^{\frac{\theta}{\lambda} + 2} + d z^{\frac{\theta}{\lambda} + 4} + \dots$  &c. and let  $\frac{\theta}{\lambda}$  be put  $= r$ , and  $r + \lambda = S$ ,  $S + \lambda = t$ ,  $t + \lambda = v$ , &c. Then

the Area will be  $z^{\theta} R^{\lambda}$  multiply'd into  $\frac{a}{r} + \frac{\frac{1}{2} b - S f A}{r+1, e} z^{\frac{\theta}{\lambda}} + \frac{\frac{1}{2} C - \frac{1}{2} f B - t g A}{r+2, e} z^{\frac{\theta}{\lambda} + 2} + \frac{\frac{1}{2} d - \frac{1}{2} f C - \frac{1}{2} g B - v h A}{r+3, e} z^{\frac{\theta}{\lambda} + 4} + \dots$   
 $z^{\theta} + \frac{\frac{1}{2} f D - \frac{1}{2} g C - \frac{1}{2} h B}{r+4, e} z^{\frac{\theta}{\lambda} + 6} + \dots$  &c. where  $A, B, C, D$ , &c. denote the whole given Co-efficients of each Term in the Series with their Signs  $+$  and  $-$ , viz.  $A$  denotes the Co-efficient of the first Term  $\frac{a}{r}$ ,  $B$  the Co-efficient of the second Term  $\frac{\frac{1}{2} b - S f A}{r+1, e}$ ,  $C$  the Co-efficient of the third Term  $\frac{\frac{1}{2} C - \frac{1}{2} f B - t g A}{r+2, e}$ , and so on.

Demonstration.

According to Prop. Third.

|  |                            |
|--|----------------------------|
| Let the Ordinates of the Curves be,  | and their Areas            |
| 1. $\theta e A + \frac{\theta}{\lambda} f A z^{\frac{\theta}{\lambda}} + \frac{\theta}{2\lambda} g A z^{\frac{\theta}{\lambda} + 2} + \dots$ | $A z^{\theta} R^{\lambda}$ |
| 2. $\dots \frac{\theta}{\lambda} e B z^{\frac{\theta}{\lambda}} + \frac{\theta}{\lambda} f B z^{\frac{\theta}{\lambda} + 2} + \dots$         | $B z^{\theta} R^{\lambda}$ |
| 3. $\dots \frac{\theta}{2\lambda} e C z^{\frac{\theta}{\lambda} + 2} + \dots$  | $C z^{\theta} R^{\lambda}$ |
| 4. $\dots \frac{\theta}{\lambda} e D z^{\frac{\theta}{\lambda} + 4} + \dots$   | $D z^{\theta} R^{\lambda}$ |

And if the Sum of the Ordinates be put equal to the Ordinate  $a + b z^{\frac{\theta}{\lambda}} + c z^{\frac{\theta}{\lambda} + 2} + d z^{\frac{\theta}{\lambda} + 4} + \dots$  &c. multiply'd into  $z^{\theta-1} R^{\lambda-1}$ , the Sum of the Areas  $z^{\theta} R^{\lambda}$

into  $A + B z^{\frac{\theta}{\lambda}} + C z^{\frac{\theta}{\lambda} + 2} + D z^{\frac{\theta}{\lambda} + 4} + \dots$  &c. will be equal to the Area of a Curve which has that for an Ordinate. Therefore let the corresponding Terms of the Ordinate be equal; and then  $a$  will become  $= \theta e A$ ,  $b = \frac{\theta}{\lambda} f A + \theta e B$ ;  $C = \frac{\theta}{2\lambda} g A + \frac{\theta}{\lambda} f B + \theta e C$ , &c. and thence  $\frac{a}{\theta} = A$ ,  $\frac{b - \frac{\theta}{\lambda} f A}{\theta + \lambda} = B$ ,  $\frac{C - \frac{\theta}{2\lambda} g A - \frac{\theta}{\lambda} f B}{\theta + 2\lambda} = C$ . And so on *ad Infinitum*.

Now put  $\frac{\theta}{\lambda} = r$ ,  $r + \lambda = S$ ,  $S + \lambda = t$ , &c. and in the Area  $z^{\theta} R^{\lambda} \times A + B z^{\frac{\theta}{\lambda}} + C z^{\frac{\theta}{\lambda} + 2} + D z^{\frac{\theta}{\lambda} + 4} + \dots$  &c. write the values of  $A, B, C$  found above, and there will come out the propos'd Series. Q. E. D.

And it is to be observed, that every Ordinate is resolved into a Series two ways: For the Index  $n$ , may either be Affirmative or Negative. Let an Ordinate be proposed  $3k - l z z$

$\frac{3k - l z z}{z z \sqrt{k z - l z z + m z^3}}$  this may be either written  $z - \frac{5}{2} \times 3k - l z z \times k - l z z + m z^3$  or thus,  $z \times -1 + 3k z^{-2} \times m - l z^{-1} + k z^{-3}$ . In the former Case  $a = 3k$ ,  $b = 0$ ,  $c = -l$ ,  $E = k$ ,  $f = 0$ ,  $g = -l$ ,  $h = m$ ,  $\lambda = -\frac{1}{2}$ ,  $\eta = 1$ ,  $\theta - 1 = -\frac{5}{2}$ ,  $\theta = -\frac{3}{2}$ ,  $t = r$ ,  $S = -1$ ,  $t = -\frac{1}{2}$ ,  $v = 0$ . In the latter Case,  $a = -l$ ,  $b = 0$ ,  $C = 3k$ ,  $e = m$ ,  $f = -l$ ,  $g = 0$ ,  $h = 1$ ,  $\lambda = -\frac{1}{2}$ ,  $\eta = -1$ ,  $\theta - 1 = l$ ,  $\theta = 2$ ,  $r = -2$ ,  $S = -1\frac{1}{2}$ ,  $t = -1$ ,  $v = -\frac{1}{2}$ : Each of these Cases must be try'd; and if either of the Series be broken off and terminated, the Terms at length growing different, the Area of the Curve will be had in finite Terms. So in the former Case of this Example, by writing in the Series the Values of  $a, b, c, e, f, g, h, \lambda, \theta, r, s, t, v$ , all the Terms except the first vanish *ad infinitum*, and the Area of the Curve becomes  $-2 \sqrt{\frac{k - l z z + m z^3}{z^3}}$ . And this Area, by Reason

of the negative Sign, adjoins to the Abscissa produced beyond the Ordinate. For every Affirmative Area adjoins to both the Abscissa and Ordinate, but a Negative one falls on the contrary parts of the Ordinate, and adjoins to the Abscissa produced, the Sign of the Ordinate remaining. By this means one of the Series, and sometimes both, is always terminated and finite; if the Curve can be squared Geometrically.

But if the Curve don't admit of such a Quadrature, both Series will be continued *in infinitum*, and one of them will converge and give the Area by Approximation, except where  $r$  (by reason of the infinite Area) is either nothing or an Integer Number and Negative, or where  $\frac{z}{e}$  is equal to Unity. If  $\frac{z}{e}$  be less than Unity, that Series will converge in which the Index  $n$  is affirmative; but if  $\frac{z}{e}$  be greater than Unity, the other Series will converge. In one Case the Area adjoins to the Abscissa drawn as far as the Ordinate, in the other Case it adjoins to it produced beyond the Ordinate.

Note farther, that if the Ordinate be a Rectangle under the Rational Factor  $Q$  and the Surd irreducible Factor  $R^{\pi}$ , and the side  $R$  of the Surd Factor does not divide the Rational Factor  $Q$ ; then  $\lambda - 1$  will be  $= \pi$ ; and  $R^{\lambda-1} = R^{\pi}$ ; but if the Side  $R$  of the Surd Factor divide the Rational Factor once,  $\lambda - 1$  will be  $= \pi + 1$ , and  $R^{\lambda-1} = R^{\pi+1}$ ; if it divide it twice,  $\lambda - 1$  will be  $= \pi + 2$



and  $R^{\lambda-1}=R^{\pi+2}$ : If thrice,  $\lambda-1$  will be  $=\pi+3$  and  $R^{\lambda-1}=R^{\pi+3}$ , and so on, &c.

If the Ordinate be a rational irreducible Fraction whose Denominator is composed of two or more Terms; the Denominator is to be resolved into all its first Divisors. And if there be any Divisor which has never another equal to it, the Curve is not Quadrable. But if there be two or more Divisors equal, one of them must be thrown away, and still there will be two others or more, which are equal amongst themselves and unequal to the former; one of these also must be rejected, and so of all others that are equal, if there still be more; then the Divisor that is left, or the Product under all the Divisors which are left, if there be more, must be put instead of  $R$  and  $R^{-2}$  the reciprocal of the Square of  $R$  for  $R^{\lambda-1}$ , except where that Product is a Square, or a Cube, or a Biquadrate, &c. in which case the side of it is to be put instead of  $R$ , and the Index of the Power 2, 3, or 4, taken negatively instead of  $\lambda$ ; and the Ordinate must be reduced to the Denominator  $R^2$ ,  $R^3$ ,  $R^4$ , or  $R^5$ , &c.

Let the Ordinate be  $\frac{25+z^4-8z}{25+z^4-5z^3-2z^2-8z-4}$ ; because this Fraction is irreducible, and the Divisors of the Denominator are equal, viz.  $z-1$ ,  $z-1$ ,  $z-1$ ,  $z+2$ , &  $z \times 2$ , I reject one Divisor of either magnitude, and the Product of the remaining  $z-1$ ,  $z-1$ ,  $z-2$ , which is  $z^3-3z+2$  I put instead of  $R$ ; and the Reciprocal of the Square of  $R$  which is  $\frac{1}{R^2}$  or  $R^{-2}$  instead of  $R^{\lambda-1}$ . Afterwards I reduce the Ordinate to the Denominator  $R^2$  or  $R^{\lambda-1}$ , and it becomes  $\frac{z^6-2z^4+8z^3}{z^3-3z+2}$ , that is,  $\frac{z^3 \times 8 - 9z + z^3 \times 2 - 3z + z^3}{z^3-3z+2}$ . And thence is  $a=8$ .  $b=-9$ .  $C=0$ .  $d=-1$ , &c.  $E=2$ .  $f=-3$ .  $g=0$ .  $h=1$ .  $\lambda-1=-2$ .  $\lambda=-1$ .  $\eta=1$ .  $\theta-1=3$ .  $\theta=4=r$ .  $S=5$ .  $t=2$ .  $v=1$ . and these being put in the Series, the Area comes out  $\frac{z^4}{z^3-3z+2}$ ; all the Terms in the Series, except the first, vanishing.

If lastly, the Ordinate be an irreducible Fraction, whose Denominator is a Product under the Rational Factor  $Q$ , and the Surd irreducible Factor  $R^{\pi}$ , you must find all the first Divisors of the Side  $R$ , and reject one Divisor of each Magnitude; and by those Divisors that remain, if there be any, multiply the Rational Factor  $Q$ ; and if that Product be equal to the Side  $R$ , or any

Power of that Side whose Index is an Integer Number; let that Index be  $m$ , and  $\lambda-1$  will be  $=-\pi-m$  and  $R^{\lambda-1}=R^{-\pi-m}$ , so that if the Ordinate be  $\frac{3q^5-q^4x+9q^2xx-qqx^3-6qx^4}{qq-xx^2 \sqrt{q^2+qqx-qqx-x^2}}$ , because the side  $R$  of the Surd Factor or  $q^2+qqx-qqx-x^2$  has the Divisors  $q+x$ ,  $q+x$ ,  $q-x$ , which are of two Magnitudes, I reject one Divisor of each Magnitude, and multiply the Rational Factor  $qq-xx$  by the Divisor that is left  $q+x$ . And because the Product  $q^3+qqx-qqx-x^3$  is equal to the side  $R$ , I put  $m=1$ . and thence, since  $\pi$  is  $\frac{1}{2}$ ,  $\lambda-1$  becomes  $=-\frac{3}{2}$ . Therefore I reduce the Ordinate to the Denominator  $R^{-\frac{3}{2}}$ , and 'tis made  $\frac{30 \times 3q^6+2q^5x+8q^4xx+8q^3x^2+7qqx^3+6qx^4+qqx-x^3}{x-x^3}$ . from whence  $a$  is  $=3q^6$ .  $b=2q^5$ , &c.  $e=q^3$ .  $f=qq$ , &c.  $\theta-1=0$ .  $\theta=1=\eta$ .  $\lambda=-\frac{3}{2}$ .  $r=1$ .  $S=\frac{3}{2}$ .  $t=1$ .  $v=0$ . and these Values being put in the Series, the Area comes out  $\frac{3qqx+x^3}{\sqrt{q^2+qqx-qqx-x^2}}$ , all the Terms in the whole Series after the third, vanishing.

Prop. 6. Theor. 4.

If the Abscissa  $AB$  of a Curve be  $z$ , and  $R$  be put in the room of  $e+fx^n+gz^{2n}+hz^{3n}+$ , &c. and  $S$  in the room of  $k+lx^n+mx^{2n}+nx^{3n}$ , &c. then let the Ordinate Applicate be  $sz^{\theta-1} R^{\lambda-1} S^{\mu-1}$  multiply'd into  $a+bz^n+Cz^{2n}+dz^{3n}$ , &c. if there be the Rectangles of the Terms  $e$ ,  $f$ ,  $g$ ,  $h$ , &c. and  $k$ ,  $l$ ,  $m$ ,  $n$ , &c.

$$\left. \begin{array}{cccc} ek & fk & gk & hk \\ el & fl & gl & hl \\ em & fm & gm & hm \\ en & fn & gn & hn \end{array} \right\} \&c.$$

And if the numeral Co-efficients of those Rectangles be respectively,

$$\begin{array}{cccc} \frac{1}{n}=r, & r+\lambda=S. & S+\lambda=t. & t+\lambda=v. \&c. \\ r+\mu=S. & S+\mu=t. & t+\mu=v. & v+\mu=w. \&c. \\ " & " & " & " \\ S+\mu=t. & t+\mu=v. & v+\mu=w. & w+\mu=x. \&c. \\ " & " & " & " \\ t+\mu=v. & v+\mu=w. & w+\mu=x. & x+\mu=y. \&c. \end{array}$$

The Area of the Curve will be

$$\begin{array}{l} \frac{-Sfk}{rek} + \frac{\frac{1}{2}b - Sel}{r+1, ek} z^n + \frac{\frac{1}{2}C - S+1, el}{r+2, ek} z^{2n} + \frac{-tem}{r+3, ek} z^{3n} + \&c. \\ \frac{-vbk}{rek} + \frac{\frac{1}{2}d - S+2, el}{r+3, ek} z^{3n} + \&c. \end{array}$$

Where  $A$  denotes the given Co-efficient of the first Term,  $\frac{1}{2}a$  with its Sign  $+$  or  $-$ ,  $B$  the given

Co-efficient of the second Term,  $C$  the given Co-efficient of the Third, and so on. But of the Terms  $a$ ,  $b$ ,  $c$ , &c.  $e$ ,  $f$ ,  $g$ , &c.  $k$ ,  $l$ ,  $m$ , &c. one or more



more may be wanting. This Proposition is demonstrated after the manner of the former, and what was observed there takes place here also. But the Series of such Propositions as these run on *ad infinitum*, and the Progression of the Series is evident.

Prop. 7. Theor. 5.

If  $R$  be put instead of  $e + fz^n + gz^{2n}$ , &c. as above, and in the Ordinate of any Curve  $z\theta + n\sigma R\lambda + \tau$  there remains the given Quantities  $\theta, n, \lambda, e, f, g$ , &c. and instead of  $\sigma$  and  $\tau$  be put any Integer Numbers successively, and if the Area of one of these Curves be given, which are denoted by innumerable Ordinates coming out in these forms, if the Ordinates be Binomials in the *Vinculum* of the Root, or if the Areas of two of those Curves be given; if the Ordinates be Trinomials in the *Vinculum* of the Root, or the Areas of three of those Curves; if the Ordinates are Quadrinomials in the *Vinculum* of the Root, and so on infinitely: I say, that the Areas of all these Curves will be given. For *Nomes* I here take all the Terms in the *Vinculum* of the Root, as well deficient as entire, the Indexes of whose Powers are in an Arithmetical Progression. So the Ordinate  $\sqrt{a^4 - ax^3 + x^4}$  by reason of the two different Terms between  $ax$  and  $ax^3$  ought to be reckoned a Quinquenomial. But  $\sqrt{a^4 + x^4}$  is a Binomial, and  $\sqrt{a^4 + x^4 - x^8}$

— a Trinomial, seeing the Progression now proceeds by greater differences, This Proposition is thus demonstrated.

Case 1.

Let the Ordinates of two Curves be  $p z^{2\theta-1} R^{\lambda-1}$  and  $q z^{2\theta+n-1} R^{\lambda-1}$ , and their Areas  $p A$  and  $q B$ ,  $R$  being the Trinomial Quantity  $e + fz^n + gz^{2n}$ . And by Prop 3. since  $z\theta R^\lambda$  is the Area of a Curve whose Ordinate is  $\theta e + \theta f z^n + \theta g z^{2n}$  multiply'd into  $z^{2\theta-1} R^{\lambda-1}$ , subtract the former Ordinates and Areas from this latter Ordinate and Area, and there will remain  $\theta e + \theta f z^n + \theta g z^{2n}$  multiply'd into  $z^{2\theta-1} R^{\lambda-1}$  the new Ordinate of the Curve; and  $z^\theta R^\lambda - p A - q B$  its Area. Put  $\theta e = p$ , and  $\theta f + \lambda n f = q$  and the Ordinate will be found

$\frac{\theta}{+2\lambda n} g z^{2n}$  multiplied into  $z^{2\theta-1} R^{\lambda-1}$ , and the Area  $z^\theta R^\lambda - \theta e A - f B - \lambda n f B$ . Divide both by  $\theta g + 2\lambda n g$ , and call the Area that will come out  $C$ , and taking  $r$  at pleasure,  $r C$  will be the Area of a Curve whose Ordinate is  $r z^\theta + 2n-1 R^{\lambda-1}$ . And after the same manner that from the Areas  $p A$  and  $q B$  we find the Area  $r C$  agreeing to the Ordinate  $r z^\theta + 2n-1 R^{\lambda-1}$ , we may from the Areas  $q B$  and  $r C$  find a fourth Area, as  $S D$ , agreeing to the Ordinate  $S z^\theta + 3n-1 R^{\lambda-1}$ , and so on infinitely. And from the Areas  $B$  and  $A$  there is a like Ratio of Progression towards a contrary part. If any of the Terms  $\theta, \theta + \lambda n$ , and  $\theta + 2\lambda n$  be wanting, and break off the Series, assume the Area  $p A$  in the beginning of one Progression, and the Area  $q B$  in the beginning of the other, and from these two Areas will be given all the Areas in both Progressions.

And on the contrary, from any two other Areas assumed, one may go back by an Analysis to the Areas  $A$  and  $B$ ; so that from these two Areas given, all the rest may be given likewise, *Q. E. D.* This is the case of these Curves where  $\theta$  the Index of  $z$  is increased or diminished by a perpetual addition or subtraction of the Quantity  $n$ . The other is the Case of those Curves where the Index  $\lambda$  is increased or diminished by Units.

Case 2.

If the Ordinates  $p z^{2\theta-1} R^\lambda$  and  $q z^{2\theta+n-1} R^\lambda$ , whose corresponding Areas are  $p A$  and  $q B$ , be multiply'd by  $R$ , or  $e + fz^n + gz^{2n}$ , and afterwards be again divided by  $R$ , they become  $p e + p f z^n + p g z^{2n} \times z^{2\theta-1} R^{\lambda-1}$ , and  $q e z^n + q f z^{2n} + q g z^{3n} \times z^{2\theta-1} R^{\lambda-1}$ . And by the 3d Prop.  $az^\theta R^\lambda$  is the Area of a Curve whose Ordinate is  $\theta a e + \theta a f z^n + \theta a g z^{2n}$  multiply'd into  $z^{2\theta-1} R^{\lambda-1}$ , and  $b z^\theta + n R^\lambda$  is the Area of a Curve whose Ordinate is  $\theta b e z^n + \theta b f z^{2n} + \theta b g z^{3n}$  multiply'd into  $z^{2\theta-1} R^{\lambda-1}$ . The Summ of these 4 Areas is  $p A + q B + a z^\theta R^\lambda + b z^\theta + n R^\lambda$ , and the Summ of their corresponding Ordinates.

$$\begin{array}{r} \theta a e + \theta a f z^n + \theta a g z^{2n} + \theta b e z^n + \theta b f z^{2n} + \theta b g z^{3n} \\ + p e + p f z^n + p g z^{2n} + q e z^n + q f z^{2n} + q g z^{3n} \end{array}$$

If the First, Third and Fourth Term be separately put equal to nothing; by the first Term,  $\theta a e + p e$  will be made  $= 0$  or  $-\theta a = p$ , by the Fourth  $-\theta b - n b - 2\lambda n b =$ , and by the Third (striking out  $p$  and  $q$ )  $\frac{2ag}{f} = b$ . From whence the second Term becomes  $\frac{\lambda n a f f - 4\lambda n a g e}{f}$ , and therefore the Summ of the four Ordinates is  $\frac{\lambda n a f f - 4\lambda n a g e}{f} z^{2\theta+n-1} R^{\lambda-1}$ , and the Summ of so many corresponding Areas is  $a z^\theta R^\lambda + \frac{2ag}{f} z^{2\theta+n} R^{\lambda+1}$

$a A - \frac{2\theta + 2n + 4\lambda n}{f} a g B$ . Divide these Summs by  $\frac{\lambda n a f f - 4\lambda n a g e}{f}$ , and if the latter Quote be called  $D$ ;  $D$  will be the Area of a Curve whose Ordinate is the first Quote  $z^{2\theta+n-1} R^{\lambda-1}$ . And after the same way by putting all the Terms of the Ordinate except the first equal to nothing, the Area of a Curve may be found whose Ordinate is  $z^{2\theta-1} R^{\lambda-1}$ . Let that Area be called  $C$ , the same way that the Areas  $C$  and  $D$  are found from the Areas  $A$  and  $B$ , two other  $E$  and  $F$  may be found from  $C$  and  $D$ , agreeing to the Ordinates  $z^{2\theta-1} R^{\lambda-2}$  and  $z^{2\theta+n-1} R^{\lambda-2}$ , and so on *in infinitum*: And by a contrary Analysis one may proceed back again from the Areas  $E$  and  $F$  to the Areas  $C$  and  $D$ , and thence to



the Areas  $A$  and  $B$ , and others which follow in the Progression. Therefore if the Index  $\lambda$  be encreased or diminished by a continual addition or subduction of Unities; and of the Areas, corresponding to the Ordinates coming out in these Forms; two of the most simple be known, all others are given in infinitum. Q. E. D.

Case 3.

And by these two Cases conjoined, if both the Index  $\theta$  be any how increased or diminished by the continual addition or subduction of  $n$ ; and the Index  $\lambda$ , by the perpetual addition or subduction of Unity, the Areas corresponding to the several arising Ordinates, will be given.

Case 4.

And by the like encrease, if the Ordinate be expressed by 4 Nomes in the Radical Vinculum, and 3 of the Areas are given; or if it be express'd by 5 Nomes and 4 of the Areas given, and so on: All the Areas will be given which can be generated by adding or subducting the Number  $n$  to or from the Index  $\theta$ ; or Unity, to or from the Index  $\lambda$ . And 'tis the same case with Curves whose Ordinates are expressed by Binomials and one Area of those which are not Quadrable Geometrically, is given.

Prop. 8. Theor. 6.

If for  $e + fz^n + gz^{2n} + \&c.$  and  $k + lz^n + mz^{2n} + \&c.$  you put  $R$  and  $S$  as before, and in the Ordinate of any Curve  $z^{\theta} + n\sigma R^{\lambda} + \tau S^{\mu} + \nu$  the given Quantities  $\theta, n, \lambda, \mu, e, f, g, k, l, m, \&c.$  remain: and that for  $\sigma, \tau$ , and  $\nu$ , any Integer Numbers be successively written, and if the Areas of two of the Curves are given which are denoted by the Ordinates so arising, if the Quantities  $R$  and  $S$  are Binomials; or if the Areas of three of the Curves be given, if  $R$  and  $S$  consist conjointly of 5 Nomes; or if the Areas of 5 Curves be given, when  $S$  and  $R$  consist jointly of six Nomes, &c. and so on in infinitum: I say, the Areas of all the Curves will be given.

The Demonstration is like that of the former Proposition.

Prop. 9. Theor. 7.

The Areas of these Curves are equal to one another whose Ordinates are as the Fluxions of the Abscissa.

For the Rectangles under the Ordinates and the Fluxions of the Abscissa are equal, and the Fluxions of the Areas are as those Rectangles.

Corol. 1.

If any Relation between the Abscissa of two Curves be assumed, and thence (by Prop. 1.) the Relation between the Fluxions of the Abscissa be sought, and the Ordinates be supposed reciprocally proportionable to the Fluxions; then innumerable Curves may be found, whose Areas shall be mutually equal to one another.

Corol. 2.

For so will every Curve whose Ordinate is

$z^{\theta-1}$  into  $e + fz^n + gz^{2n} + \&c.$ , by assuming any Quantity for  $v$ , and putting  $\frac{v}{z} = S$  and  $zS = x$ , change into another equal to it self, whose Ordinate will be  $\frac{v}{x} \frac{v^{\theta-n}}{x^n}$  into  $e + fxv + gx^2v + \&c.$

Corol. 3.

And every Curve whose Ordinate is  $z^{\theta-1}$  into  $a + bz^n + cz^{2n} + \&c.$   $\times$   $e + fz^n + gz^{2n} + \&c.$ , by taking any Quantity for  $v$  and putting  $\frac{v}{z} = S$ , and  $zS = x$ , will change into another equal to it self whose Ordinate shall be  $\frac{v}{x} \frac{v^{\theta-n}}{x^n}$  into  $a + bxv + cx^2v + \&c.$   $\times$   $e + fxv + gx^2v + \&c.$

Corol. 4.

And every Curve whose Ordinate is  $z^{\theta-1}$  into  $a + bz^n + cz^{2n} + \&c.$   $\times$   $e + fz^n + gz^{2n} + \&c.$   $\times$   $k + lz^n + mz^{2n} + \&c.$ , by taking any Quantity for  $v$  and putting  $\frac{v}{z} = S$  and  $zS = x$ , changes into another Curve equal to it self, whose Ordinate is  $\frac{v}{x} \frac{v^{\theta-n}}{x^n}$  into  $a + bxv + cx^2v + \&c.$   $\times$   $e + fxv + gx^2v + \&c.$   $\times$   $k + lxv + mx^2v + \&c.$

Corol. 5.

And every Curve whose Ordinate is  $z^{\theta-1}$  into  $e + fz^n + gz^{2n} + \&c.$  by putting  $\frac{1}{z} = x$ , changes into another equal to it self, whose Ordinate is  $\frac{1}{x^{\theta+1}}$   $\times$   $e + fx^n + gz^{2n} + \&c.$  that is  $\frac{1}{x^{\theta+1+n\lambda}}$   $\times$   $f + ex^n$ , if there are two Nomes in the Vinculum of the Root, or  $\frac{1}{x^{\theta+1+2n\lambda}}$   $\times$   $g + fx^n + ex^{2n}$  if there are three Nomes, &c.

Corol. 6.

And every Curve whose Ordinate is  $z^{\theta-1}$  into  $e + fz^n + gz^{2n} + \&c.$   $\times$   $k + lz^n + mz^{2n} + \&c.$ , by putting  $\frac{1}{z} = x$ , changes into another equal to it self, whose Ordinate is  $\frac{1}{x^{\theta+1}}$   $\times$   $e + fx^n + gx^{2n} + \&c.$   $\times$   $k + lx^n + mx^{2n} + \&c.$ , that is  $\frac{1}{x^{\theta+1+n\lambda+n\mu}}$   $\times$   $f + ex^n \times l + kx^n \mu$  if there are two Nomes in the Vinculum of the Root, or  $\frac{1}{x^{\theta+1+2n\lambda+n\mu}}$   $\times$   $g + fx^n + ex^{2n} \times l + kx^n \mu$ , if there be three Nomes in the Vinculum of the former Root, and two in that of the latter; and so in others.

N. B. The two equal Areas in these two last Corollaries lie on opposite sides of the Ordinates: If the Areas in either Curve join to the Abscissa, the corresponding equal Area in the other Curve adjoins to the Abscissa produced.

Corol.



## Corol. 7

If the Relation between the *Ordinate*  $y$  of any Curve and its *Abcissa*  $x$  be expressed by any affected Equation of this form,  $y^a$  into  $e + fy^{nz} + gy^{2nz} + hy^{3nz} + \&c. = z^b$  into  $k + ly^{nz} + my^{2nz} + \&c.$  this Figure, assuming  $S = \frac{n-d}{n}$ ,  $x = \frac{1}{s} z^s$ , and

$\lambda = \frac{n-d}{n+d+\beta n}$  changes into another equal to its self, whose *Abcissa*  $x$ , from the *Ordinate*  $y$  being given, is determined by an Equation not affected; as  $\frac{1}{s} a x e + f v^n + g v^{2n} + h v^{3n} + \&c. \lambda \times k + l v + m v^2 + \&c. \lambda = x$ .

## Corol. 8.

If the Relation between the *Ordinate*  $y$  of any Curve, and its *Abcissa*  $z$  be determined by any affected Equation in this Form,  $y^a$  into  $e + fy^{nz} + gy^{2nz} + \&c. = z^b$  into  $k + ly^{nz} + my^{2nz} + \&c. + z^c$  into  $p + qy^{nz} + ry^{2nz} + \&c.$  then this Figure, assuming  $S = \frac{n-d}{n}$ ,  $\lambda = \frac{1}{s} z^s$ ,  $\mu = \frac{a+d+\beta n}{n-d}$  and  $v = \frac{a+d+\gamma n}{n-d}$ , changes into another equal to it self, whose *Abcissa*  $x$ , from the given *Ordinate*  $y$  being given, is determined by an Equation less affected, as  $y^a$  into  $e + f v^n + g v^{2n} + \&c. = S x x$  into  $k + l v + m v^2 + \&c. + S v$  into  $p + q v^n + r v^{2n} + \&c.$

## Corol. 9.

Every Curve whose *Ordinate* is  $z^{b-1}$  into  $e + f z^{n+1} + g z^{2n+1} + \&c. \times e + f z^n + g z^{2n} + \&c. \lambda^{-1}$   $\times a + b l e z^n + f z^{n+1} + g z^{2n+1} + \&c. \lambda^{-1}$ , if  $\theta = \lambda v$  and there be assumed  $x = z v + f z^{n+1} + g v^{2n+1} + \&c. \lambda^{-1}$ ,  $\sigma = \frac{\tau}{\pi}$ , and  $\vartheta = \frac{\lambda - \pi}{\pi}$ , changes into another

equal to its self, whose *Ordinate* is  $x^\theta \times a + b x^\sigma$ . And observe that the former *Ordinate* in the *Corollary* becomes more simple by putting  $\lambda = 1$ , or by putting  $\tau = 1$ , and by effecting, that the Radix of the Dignity may be extracted, whose Index is  $\omega$ , or also by putting  $\omega = -1$  and  $\lambda = 1 = \tau = \sigma = \pi$ , that I may pass by other Cases, &c.

## Corol. 10.

For  $e z + f z v^{n+1} + g z v^{2n+1} + \&c. v e z v + f v f z v^{n+1} + \&c. k + l z^n + m z^{2n} + \&c.$  and  $+ z^n g z v^{2n+1} + \&c. n l z^{n-1} + n m x^{n-1} + \&c.$  let  $R, r, S$  and  $s$  be substituted respectively, and then every Curve whose *Ordinate* is  $\pi S r + \phi R s$  into  $R^{\lambda-1} S^{\mu-1} \times a S v + b R^{\tau} v^\omega$  if it be  $\frac{\mu - v \omega}{\lambda} = \frac{v}{\tau} = \frac{\phi}{\pi}$ ,  $\frac{\tau}{\pi} = \sigma$ ,  $\frac{\lambda - \pi}{\pi} = \vartheta$ , and  $R \pi S \phi = x$ , changes into another equal to it self, whose *Ordinate* is  $x^\theta \times a + b x^\sigma$ . And observe, that the former *Ordinate* grows more simple, by putting Unities for  $\tau, v, \lambda$  or  $\mu$ , and by affecting

that the Radix of the Dignity may be extracted, whose Index is  $\omega$ , or by putting  $\omega = -1$  or  $\mu = 0$ .

## Prop. 10. Prob. 3.

To find the most simple Figures with which any Curve may be Geometrically compared, whose *Ordinate* *Applicate*  $y$ , by an Equation not affected, is determined from having the *Abcissa*  $z$  given.

## Case 1.

Let the *Ordinate* be  $az^{b-1}$ , and then the Area will be  $\frac{1}{\theta} az^\theta$ , as will easily be collected from *Prop. 5.* by putting  $b = 0 = c = d = f = g = h$  and  $e = 1$ .

## Case 2.

Let the *Ordinate* be  $az^{b-1} \times f z^n + g z^{2n} + \&c. \lambda^{-1}$  then if the Curve can be compared Geometrically with *Rectilinear Figures*, it may be squared by *Prop. 5.* by putting  $b = c = d$ . If not, let it be changed into another Curve equal to it, whose *Ordinate* shall be  $\frac{a}{\theta} \frac{\theta - n}{n} x e + f x + g x^2 + \&c. \lambda^{-1}$  by *Cor. 2. Prop. 9.*

Then if out of the Index of the Dignities  $\frac{\theta - n}{n}$  and  $\lambda - 1$  (by *Prop. 7.*) you reject the Unities till those Dignities become the least possible, you will then come to the most simple Figures that can be by this means collected. Then every one of these, (by *Cor. 5. Prop. 9.*) gives another which is sometimes yet more simple. And from these, by *Prop. 3.* and *Cor. 9.* and *10.* of *Prop. 9.* compared one with another, some yet more simple Figures come out. And lastly, by assuming these to be the most simple Figures; and by proceeding in a Reverse or Inverse Method, may the required Area be computed.

## Case 3.

Let the *Ordinate* be  $z^{\theta-1} \times a + b z^n + c z^{2n} + \&c. x e + f z^n + g z^{2n} + \&c. \lambda^{-1}$ , then will this Figure, if squarable, be squared by *Prop. 5.* But if not, then the *Ordinate* must be distinguished into the Parts,  $v^{\theta-1} \times a \times e + f z^n + g z^{2n} + \&c. \lambda^{-1}$ ,  $z^{\theta-1} \times b z^n \times e + f z^n + g z^{2n} + \&c. \lambda^{-1}$ , &c. and by *Case 2.* the most simple Figures are to be found with which the Figures corresponding in those Parts may be compared; for then the Areas of the Figures corresponding to those Parts, and connected with their proper Signs  $+$  and  $-$ , will compose the whole Area sought.

## Case 2.

Let the *Ordinate* be  $z^{\theta-1} \times a + b z^n + c z^{2n} + \&c. x e + f z^n + g z^{2n} + \&c. \lambda^{-1} \times k + l z^n + m z^{2n} + \&c. \mu^{-1}$  and then if the Curve be Quadrable, it will be squared by *Prop. 6.* But if not, let it by *Cor. 4. Prop. 9.* be changed into a more simple one, and then compared with the most simple Figures according



to *Prop.* 8. and *Cor.* 6, 9, and 10, of *Prop.* 9 as was done in *Case* 2 and 3.

*Case* 5.

If the Ordinate consist of different Parts, then the several Parts are to be esteemed as the Ordinates of so many different Curves, and those Curves, as many as are Quadrable, are to be squared, and their Ordinates subducted from that of the whole Curve.

*Corol.* 1.

Hence every Curve whose Ordinate is the Square Root of its affected Equation, may be compared with the most simple Figures, whether Rectilineal or Curvilineal. For that Root always consists of two Parts, which considered severally, are not affected Roots of Equations. Let the Equation be proposed  $aa + yy + 2zzy = 2a^3y + 2x^3y - z^4$  its Root when extract-

ed will be  $y = \frac{a^3 + z^3 + a\sqrt{a^4 + 2xz - z^4}}{aa + zz}$  whose ra-

tional part  $\frac{a^3 + z^3}{aa + zz}$  and its Surd or Irrational Part

$\frac{a\sqrt{a^4 + 2xz - z^4}}{aa + zz}$  are the Ordinates of Curves that may either be squared by this Proposition, or compared with the most simple Figures, with whom they admit a Geometrical Comparison.

*Corol.* 2.

And every Curve whose Ordinate is determined by any affected Equation, which by *Cor.* 7. *Prop.* 9.

doth not go into an Equation not affected, is either, if squarable at all, squared by this Proposition, or else is compared with the most simple Figures possible. And by this means is every Curve squared, whose Equation consists of three Terms; for if that Equation be affected, 'tis changed into one not so by *Cor.* 7. *Prop.* 9. and then by *Cor.* 2. and 5. of *Prop.* 9. passing into a most simple one, either gives the Quadrature of the Figure, if it be squarable, or a most simple Curve, with whom it may be compared.

*Corol.* 3.

And every Curve whose Ordinate is determined by any affected Equation, which by *Cor.* 8. of *Prop.* 9. passes into a Quadratick affected Equation; is either squared by this *Prop.* and its first *Corollary*, if quadrable at all, or else is compared with the most simple Figures, and with which it admits a Geometrical Collation.

*Scholium.*

When Figures are to be squared, it will be too troublesome always to have recourse to these General Rules: wherefore it is better once to square the most simple and useful Figures, and then to keep Tables of such Quadratures, to which to have recourse whenever such a kind of Curve is to be squared. Of this kind are the two following Tables; in which  $z$  denotes the *Abscissa*,  $y$  the *Rectangular Ordinate*,  $e$  the *Area* of the Curve to be squared, and  $d, e, f, g, h$  and  $n$  represent given Quantities with their Signs  $+$   $-$ .

A TABLE of the more Simple Quadrable Curves.

| The Forms of the Curves.   | The Areas of the Curves.  |
|--|---|
| Form 1.<br>$dz_n = y$  | $\frac{d}{n} z_n = t.$  |
| Form 2.<br>$\frac{dz_{n-1}}{ee + 2efz_n + ffz_n^2} = y.$   | $\frac{dz_n}{nee + nefz_n} = t, \text{ or } \frac{-d}{nef + nffz_n} = t.$   |
| Form 3.<br>1. $dz_{-1}^n \sqrt{e + fz^n} = y:$<br>2. $dz_{-1}^{2n} \sqrt{e + fz^n} = y.$<br>3. $dz_{-1}^{3n} \sqrt{e + fz^n} = y.$<br>4. $dz_{-1}^{4n} \sqrt{e + fz^n} = y.$ | $\frac{2d}{3nf} R^3 = t. \text{ supposing } R = \sqrt{e + fz^n}$<br>$\frac{-4e + 6fz_n}{15nff} dR^3 = t.$<br>$\frac{16ee - 24efz_n + 3offz_n^2}{105nf^3} dR^3 = t.$<br>$\frac{-96e^3 + 144eefz_n - 18off^2z_n^2 + 21off^3z_n^3}{945nf^4} dR^3 = t.$ |
| Form 4.<br>1. $\frac{dz_{-1}^2}{\sqrt{e + fz^n}} = y.$<br>2. $\frac{dz_{-1}^2}{\sqrt{e + fz^n}} = y$   | $\frac{2d}{nf} R = t.$<br>$\frac{-4e + 2fz_n}{3nff} R = t.$   |







Form 3.

Fig. 6. 1.  $\frac{d}{z} \sqrt{e+fzn} = y. \frac{I}{zn} = xx. \sqrt{fx+exx} = v. \frac{4de}{nf} \text{ into } \frac{v3}{2ex} - s = s = \frac{4de}{nf} \text{ into a GDT, or APDB} \div \text{TDB}$

Or thus,  $\frac{I}{zn} = x. \sqrt{fx+exx} = v. \frac{8dee}{nf} \text{ into } s - \frac{fv}{2} - \frac{ffv}{4ex} = t = \frac{8dee}{nf} \text{ into a GDA} + \frac{ffv}{4ex}$

2.  $\frac{d}{zn+1} \sqrt{e+fzn} = y. \frac{I}{zn} = xx. \sqrt{fx+exx} = v. \frac{2d}{n} s = t = \frac{2d}{n} \text{ APDB, or } \frac{2d}{n} \text{ a GDB.}$

Or thus,  $\frac{I}{zn} = x. \sqrt{fx+exx} = v. \frac{4de}{nf} \text{ into } s - \frac{fv}{2} - \frac{4de}{nf} = t = \frac{4de}{nf} \times \text{a G D K:}$

3.  $\frac{d}{z^{2n+1}} \sqrt{e+fzn} = y. \frac{I}{zn} = x. \sqrt{fx+exx} = v. \frac{d}{n} s = t = \frac{d}{n} \times \text{a G D B or B D P K.}$

4.  $\frac{z^{3n+1}}{d} \sqrt{e+fzn} = y. \frac{I}{zn} = x. \sqrt{fx+exx} = v. \frac{3dfs-2dv3}{6ne} = t.$

Form 4.

Fig. 6. 1.  $\frac{d}{z\sqrt{e+fzn}} = y. \frac{I}{zn} = xx. \sqrt{fx+exx} = v. \frac{4d}{nf} \text{ into } \frac{1}{2} xv \div s = t = \frac{4d}{nf} \text{ into PAD or into a GDA}$

Or thus,  $\frac{I}{zn} = x \sqrt{fx+exx} = v. \frac{8de}{nf} \text{ into } s - \frac{1}{2} xv - \frac{fv}{4e} = t = \frac{8de}{nf} \text{ into a GDA.}$

2.  $\frac{d}{z^{n+1}\sqrt{e+fzn}} = y. \frac{I}{zn} = xx. \sqrt{fx+exx} = v. \frac{2d}{ne} \text{ into } s - xv = t = \frac{2d}{ne} \text{ into POD, or into AODG a}$

Or thus,  $\frac{I}{zn} = x. \sqrt{fx+exx} = v. \frac{4d}{nf} \text{ into } xv \div s = t = \frac{4d}{nf} \text{ into a DG a.}$

3.  $\frac{d}{z^{n+1}\sqrt{e+fzn}} = y. \frac{I}{zn} = x. \sqrt{fx+exx} = v. \frac{d}{n^2} \text{ into } 3 \div 2xv = t = \frac{d}{n^2} \text{ into } 3\text{aDGa} \div \Delta\text{aEB.}$

4.  $\frac{d}{z^{3n+1}\sqrt{e+fzn}} = y. \frac{I}{zn} = x. \sqrt{fx+exx} = v. \frac{10dfs-15dfv-2dexxv}{6nce} = t.$

Form 5.

1.  $\frac{dz_{2n-1}}{e+fzn+gz_{2n}} = y. \sqrt{e+fzn+gz_{2n}} = x. \sqrt{\frac{d}{g} + \frac{ff-4eg}{4gg}} xx = v. \frac{xv-2s}{n} = t.$

Or thus,  $\sqrt{\frac{dz_{2n}}{e+fzn+gz_{2n}}} = x. \sqrt{\frac{d}{g} + \frac{ff+4eg}{4gg}} xx = v. \frac{xv-2s}{n} = t.$

2.  $\frac{dz_{2n-1}}{e+fzn+gz_{2n}} = y. \left\{ \begin{array}{l} \sqrt{e+fzn+gz_{2n}} = x. \sqrt{\frac{d}{g} + \frac{ff+4eg}{4gg}} xx = v. \\ fzn+gz_{2n} = \xi. \frac{I}{e+\xi} = \end{array} \right\} \frac{d\sigma+2f\xi-fxv}{2ng} = t.$

Form 6. where  $p$  is put for  $\sqrt{ff-4eg}$ .

1.  $\frac{dz_{2n-1}}{e+fzn+gz_{2n}} = y. \left\{ \begin{array}{l} \sqrt{e-p+2gz_{2n}} = x. \sqrt{d+\frac{-f+p}{2g}} xx = v. \\ \sqrt{f+p+2gz_{2n}} = \xi. \sqrt{d+\frac{-f+p}{2g}} \xi\xi = \gamma. \end{array} \right\} \frac{2xv-4s-2\xi\gamma+4\sigma}{nf} = t.$

2.  $\frac{dz_{2n-1}}{e+fzn+gz_{2n}} = y. \left\{ \begin{array}{l} \sqrt{fzn-pzn+2e} = x. \sqrt{d+\frac{-f+p}{2e}} xx = v. \\ \sqrt{fzn+pzn+2e} = \xi. \sqrt{d+\frac{-f+p}{2e}} \xi\xi = \gamma. \end{array} \right\} \frac{4s-2xv-4\sigma+2\xi\gamma}{np} = t.$

Form 7.

1.  $\frac{d}{z} \sqrt{e+fzn+gz_{2n}} = y. \left\{ \begin{array}{l} z^n = x. \sqrt{e+fzn+gz_{2n}} = v. \\ \frac{I}{zn} = \xi \sqrt{g+f\xi+e\xi\xi} = \gamma. \end{array} \right\} \frac{4dee\xi\gamma+2def\gamma-2dfv-8dee\sigma+4dfos}{4neg-nfj} = t.$

Fig. 6, 2.  $\frac{dz_{2n-1}}{z} \sqrt{e+fzn+gz_{2n}} = y. z^n = x. \sqrt{e+fzn+gz_{2n}} = v. \frac{d}{n} s = t = \frac{d}{n} \text{ into a G D B.}$



$$3. dz^{2n-1} \sqrt{e+fx+gz^{2n}}=y. z^n=x. \sqrt{e+fx+gxx}=v. \frac{d}{3ng} v^3 - \frac{df}{2ng} s = t.$$

$$4. dz^{3n-1} \sqrt{e+fx+gz^{2n}}=y. z^n=x. \sqrt{e+fx+gxx}=v. \frac{6dgx-5df}{24ng} v^3 + \frac{5dff-4deg}{16ng} s = t.$$

Form 8.

Fig. 6. I.  $\frac{dz^{n-1}}{\sqrt{e+fx+gz^{2n}}}=y. z^n=x. \sqrt{e+fx+gxx}=v. \frac{8dgs-4dgv-2dfv}{4neg-nff} = t = \frac{8dg}{4neg-nff} \times \Delta GDB + \Delta DBA.$

2.  $\frac{dz^{2n-1}}{\sqrt{e+fx+gz^{2n}}}=y. z^n=x. \sqrt{e+fx+gxx}=v. \frac{-4dfs+2dfxv+4dev}{4neg-nff} = t.$

3.  $\frac{dz^{3n-1}}{\sqrt{e+fx+gz^{2n}}}=y. z^n=x. \sqrt{e+fx+gxx}=v. \frac{3dff-2dff}{4deg^2+deg} xv - 2defv = t.$

4.  $\frac{dz^{4n-1}}{\sqrt{e+fx+gz^{2n}}}=y. z^n=x. \sqrt{e+fx+gxx}=v. \frac{4negg-nffg}{36defg+8degg_{xxv}-28defg_{xv}+10degg_v} + \frac{15deffs-2dfjg}{24neg^3-6nffg} + \frac{10deff}{16deef} = t.$

Form 9.

1.  $\frac{dz^{n-1} \sqrt{e+fx}}{g+bz^n}=y. \sqrt{\frac{d}{g+bz^n}}=x. \sqrt{\frac{df}{b} + \frac{eb-fg}{b} xx}=v. \frac{4fg-2fg_{xv}+\frac{2dfv}{x}}{nfb} = t.$

2.  $\frac{dz^{2n-1} \sqrt{e+fx}}{g+bz^n}=y. \sqrt{\frac{d}{g+bz^n}}=x. \sqrt{\frac{df}{b} + \frac{eb-fg}{b} xx}=v. \frac{4egb-2egb_{xv}+\frac{2dkv}{3} \cdot \frac{2dfg_v}{x^3}}{nfb} = t.$

Form 10.

Fig. 6. I.  $\frac{dz^{n-1}}{g+bz^n \sqrt{e+fx}}=y. \sqrt{\frac{d}{g+bz^n}}=x. \sqrt{\frac{df}{b} + \frac{eb-fg}{b} xx}=v. \frac{2xv-4s}{nf} = t = \frac{4}{nf} \Delta DGA.$

2.  $\frac{dz^{2n-1}}{g+bz^n \sqrt{e+fx}}=y. \sqrt{\frac{d}{g+bz^n}}=x. \sqrt{\frac{df}{b} + \frac{eb-fg}{b} xx}=v. \frac{4gs-2gxv+\frac{2dv}{x}}{nf} = t.$

Form 11.

1.  $dz^{n-1} \sqrt{\frac{e+fx}{g+bz^n}}=y. \left\{ \begin{array}{l} \sqrt{g+bz^n}=x. \sqrt{\frac{eb-fg}{b} + \frac{f}{b} xx}=v. \\ \sqrt{b+gz^n}=\xi. \sqrt{\frac{fg-eb}{g} + \frac{e\xi\xi}{g}}=r. \end{array} \right\} \frac{dxv; z-n-4dfs-4deg}{njg-nfb} = t.$

2.  $dz^{n-1} \sqrt{\frac{e+fx}{g+bz^n}}=y. \sqrt{g+bz^n}=x. \sqrt{\frac{eb-fg}{b} + \frac{f}{b} xx}=v. \frac{2d}{nb} s = t.$

3.  $dz^{2n-1} \sqrt{\frac{e+fx}{g+bz^n}}=y. \sqrt{g+bz^n}=x. \sqrt{\frac{eb-fg}{b} + \frac{f}{b} xx}=v. \frac{dbxv^3-3dfg_s}{2nfhb} = t.$

In these Tables the Series of the Curves, of any Form, may be continued both ways in *infinitum*; viz. In the First Table, in the Numerators, of the Areas of the 3d. and 4th. Form the Numeral Coefficients of the Initial Terms (2, -4, 16, -96, 868, &c. are generated by multiplying the Numbers -2, -4, -6, -8, -10, &c. into one another continually; and the Coefficients of the subsequent Terms are divided from the Initial ones, by multiplying them gradually. In the Third Form, by  $-\frac{1}{2}, -\frac{1}{4}, -\frac{1}{8}, -\frac{1}{16}, -\frac{1}{32},$  &c. and in the Fourth Form, by  $-\frac{1}{2}, -\frac{1}{4}, -\frac{1}{8}, -\frac{1}{16}, -\frac{1}{32},$  &c. and the Coefficients of the Denominators, 3, 15, 105, &c. are produced by multiplying the Numbers, 1, 3, 5, 7, 9, &c. into one another continually.

But in the Second Table, the Series of the Curves of the First, Second, Fifth, Sixth, Ninth and Tenth Form are found by Division alone; and of the

other Forms remaining, by help of *Prop.* the Third and Fourth, produced both ways in *infinitum*.

And as these Series may be varied by changing the Sign of the Number  $n$ : So for instance, the Curve

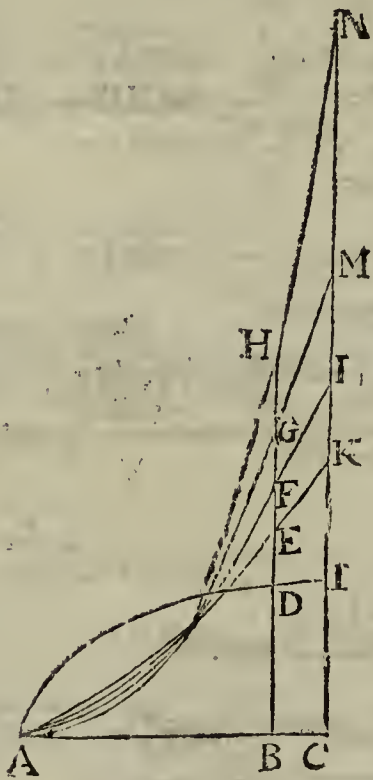
$$\frac{d}{z} \sqrt{e+fxz^n}=y \text{ becomes } \frac{d}{z^{\frac{1}{2}n+1}} \sqrt{fex^n}$$

*Prop.* 9. *Theor.* 8.

Let  $ADIC$  be any Curve having its Abscissa  $AB=z$  and its Ordinate  $BD=y$ ; and let  $A E K C$  be another Curve whose Ordinate  $BE$  is equal to the Area of the former  $ADB$  divided by Unity; and let  $AFLC$  be a Third Curve, whose Ordinate  $BF$ , is equal to the Area of the Second  $AEB$  divided by 1; and let  $AGMC$  be a Fourth Curve whose Ordinate  $BG$  is equal to the Area  $AFB$  of the Third divided by Unity; and let  $AHNC$  be



be a Fifth Curve whose Ordinate  $BH$  is equal to the Area of the Fourth  $AGB$  divided by Unity, and so on *in infinitum*. And let  $A, B, C, D, E$ , &c. be the Areas of the Curves whose Ordinates are  $y, zy, z^2y, z^3y, z^4y$ , &c. and whose common Abscissa is  $z$ .



Let any Abscissa  $AC=t$  be given, and let  $BC=t-z=x$ , and let  $P, Q, R, S, T$ , &c. be the Areas of Curves having for their Ordinates  $y, xy, x^2y, x^3y, x^4y$ , &c. and their common Abscissa  $z$ .

Let all these Areas terminate at the whole given Abscissa  $AC$ , and at the Ordinate given in Position and infinitely produced  $CI$ : And then shall the first of the Areas thus posited,  $ADIC$  be  $=A$ . The Second  $A E K C = tA - B = Q$ . The Third  $A F L C = \frac{ttA - 2tB + C}{2} = \frac{1}{2}R$ . The Fourth  $A G M C = \frac{t^2A - 2ttB + 3tC - D}{6} = \frac{1}{6}S$ . The Fifth  $A H N C = \frac{t^3A + t^2B + 6ttC - 4tD + E}{24} = \frac{1}{24}T$ .

Corol.

Whence if the Curves, whose Ordinates are  $y, zy, z^2y, z^3y$ , &c. or  $y, xy, x^2y, x^3y$ , &c. are squarable, the Curves  $ADIC, AEKC, AFLC, AGMC$ , &c. will also be squared; and the Ordinates  $BE, BF, BG, BH$ , will be proportionable to the Areas of the Curves.

Scholium.

That the Fluxions of Flowing Quantities may be considered as *First, Second, Third, Fourth*, Fluxions, &c. hath been said above: And these Fluxions are as the *Terms of infinitely converging Series*. Thus, suppose  $z^n$  a Flowing Quantity, and that by flowing it becomes  $z^n + v^n$ , then may it be resolv'd into this Converging Series  $z^n + \frac{n}{2} z^{n-1} v + \frac{n(n-1)}{6} z^{n-2} v^2 + \frac{n(n-1)(n-2)}{24} z^{n-3} v^3 + \dots$  In which Series the first Term  $z^n$  is the Flowing Quantity it self; the Second  $nz^{n-1}v$  shall be the first *Increment* or the first

Difference, to which considered as just *Nascent*, the first Fluxion is proportional. The Third Term  $\frac{n(n-1)}{2} z^{n-2} v^2$  will be the *Second Increment* or *Difference* to which considered as now *Nascent*, the Second Fluxion is proportional. The Fourth Term  $\frac{n^3 - 3nn + 2n}{6} z^{n-3} v^3$  shall be the Fluents third *Increment* or *Difference*, and to which as *Nascent*, the Third Fluxion is proportional, &c. and so on infinitely.

These Fluxions may be expounded by  $BD, BE, BF, BG, BH$ , &c. considered as the Ordinates of Curves. As if the Ordinate  $BE (= \frac{ADB}{I})$  be a *Fluent* or flowing Quantity, the first Fluxion will be as the Ordinate  $BD$ : If  $BF$  be the Fluent  $(= \frac{AEB}{I})$  the first Fluxion of it shall be as the Ordinate  $BE$ , and the second as the Ordinate  $BD$ . If  $BH (= \frac{AGB}{I})$  be the Flowing Quantity, its Fluxions considered as First, Second, Third and Fourth, shall be respectively as the Ordinates  $BG, BF, BE$ , and  $BD$ . (See the last Figure.)

Hence, in Equations which involve only two unknown Quantities, of which one is a Quantity uniformly flowing, and the other is any Fluxion of another Flowing Quantity. That other *Fluent* may be found by the *Quadrature of Curves*: Let its Fluxions be expounded or expressed by  $BD$ ; and if this be the first Fluxion, seek the Area  $ADB = BE \times I$ : If it be the Second Fluxion, let the Area  $AEB = BF \times I$  be sought; if it be the Third Fluxion, let the Area  $AFB = DG \times I$  be sought; and the Area when found, shall be the Exponent of the Flowing Quantity sought.

And also in Equations which involve a *Fluent* and its first Fluxion without any other *Fluent*; or two Fluxions of the same *Fluent*; suppose the First and Second, the Second and Third, the Third and Fourth, &c. still without any other *Fluent*: then the Fluents may be found by the Method of the *Quadrature of Curves*.

Let the Equation be  $avv = av + vv$ ; supposing  $v = BE$  and  $\dot{v} = BD$ ,  $z = AB$  and  $\dot{z} = I$ . This Equation, by compleating the Dimensions of the Fluxions will become  $avv = avz + vvz \frac{avv}{av + vv} = z$ . Suppose then  $v$  to flow uniformly, and let its Fluxion be  $\dot{v} = I$ , then shall  $\frac{aa}{av + vv} = z$ ; and by squaring the Curve whose Ordinate is  $\frac{aa}{av + vv}$  and Abscissa  $v$ , you will have the *Fluent* or Flowing Quantity  $z$ .

Again, let the Equation be  $aa \dot{v} = a \dot{z} + \dot{v} \dot{v}$ , and let  $v = BF$ ,  $\dot{v} = BE$ ,  $\ddot{v} = BD$ , and  $z = AB$ : Then by the Relation between  $\ddot{v}$  and  $\dot{v}$  or  $BD$  and  $BE$ , the Relation between  $AB$  and  $BE$  will be found as in the Example above: after which, by this Relation may the Relation between  $AB$  and  $BF$  be found, if the Curve  $AEB$  be squared.

Such Equations as involve three unknown Quantities may sometimes be reduced to such as involve only two Unknown Quantities; in which Cases the Fluents will be found from the Fluxions, as



as above. Let there be this Equation  $a - bx^m = cxy + dy^2y$ . Suppose  $y^2y = v$ , and it will stand  $a - bx^m = cxv + dv$ . This Equation, by squaring the Curve whose Abscissa is  $x$  and Ordinate  $v$ , gives the Area  $v$ ; and the other Equation  $y^2y = v$ , by working backward to the Fluents, will give  $\frac{1}{n+1} y^{n+1} = v$ : whence the Fluent  $y$  is found, and from hence, and even in such Equations as involve three unknown Quantities and which cannot be reduced to others which involve but two, the Fluents may sometimes be found by the Quadrature of Curves.

Let there be this Equation  $ax^m + bx^n = rex^{r-1}y + sexryy^{s-1} - fyy^t$ : and let  $x=1$ . Then will the latter part  $rex^{r-1}y + sexryy^{s-1} - fyy^t$  by finding the Fluents in the Inverse Method, will become  $cxy - \frac{f}{t+1} y^{t+1}$  which therefore is as the Area of a Curve whose Abscissa is  $x$  and its Ordinate  $ax^m + bx^n$ , and from thence the Fluent  $y$  will be given.

Let there be an Equation,  $x \times \overline{ax^m + bx^n} = \frac{dy^{n-1}}{\sqrt{e+fy}}$ , then the Fluent, whose Fluxion is  $x \times \overline{ax^m + bx^n}$  shall be as the Area of a Curve whose Abscissa is  $x$  and its Ordinate  $\overline{ax^m + bx^n}$ ; Also the Fluent, whose Fluxion is  $\frac{dy^{n-1}}{\sqrt{e+fy}}$  shall be as the Area of a Curve, whose Abscissa is  $y$ , and its Ordinate  $\frac{dy^{n-1}}{\sqrt{e+fy}}$ ; that is (in Case 1. by Form 4. in Table 1.) as the Area  $\frac{2d}{nf} \sqrt{e+fy}$ . Let therefore  $\frac{2d}{nf} \sqrt{e+fy}$  be equal to the Area of a Curve whose Abscissa is  $x$  and Ordinate  $\overline{ax^m + bx^n}$ , and you will have the Fluent  $y$ .

And observe, that every Fluent which is collected from the first Fluxion may be increased or diminished by any Quantity that is not a Fluent: That which arises from a second Fluxion may be augmented or lessened by any Quantity that hath no second Fluxion: That which arises from a third Fluxion may be increased or diminished by any Quantity having no third Fluxion; and so on infinitely.

After the Fluents are obtained from the Fluxions, if there be any Doubt about the Truth of the Conclusion, the Fluxions of the Fluents found, may be again gained, and compared with the Fluxions at first proposed; for they then come out equal to those, you may suppose the Conclusion right, but if they are not thus equal, the Fluents must be corrected till they come out so. For both the Fluent may be assumed at pleasure, and that assumption may be corrected by putting the Fluxion of the Fluent so assumed equal to the Fluxion proposed; and then comparing the Homologous Terms among themselves.

In *Phil. Trans.* 252. p. 708. You have a Method for the Quadrature of Figures, Geometrically irrational; by Mr. J. Craig.

See also, the same Author's *Methodus Figurarum Lineis rectis & Curvis comprehensarum Quadraturas determinandi*. Lond. 1685, 4°. And his Additions to it in *Philos. Trans.* N. 235.

See also his *Tractatus Mathematicus de Figurarum Curvilinearum Quadraturis & Locis Geometricis*. Lond. 1693, 4°.

*Vera Circuli & Hyperbolæ Quadratura in propria sua Proportionis specie inventa & demonstrata*, per Jac. Gregory, Patavii, 4.

*Le Grand & Fameux Probleme de la Quadrature du Cercle resolu Geometriquement par le Cercle & la Ligne Droite*. per M. Mallement de Messange. Paris, 1686, 12mo. See *Phil. Trans.* N. 185. where this Book is refuted by Cluverius, M. D. R. S. S.

*De Quadratura Circuli, &c.* per T. Hobbs. This Book Dr. Wallis hath twice refuted.

In *Phil. Collect.* N. 7. you have Mr. Leibnitz's Method for the Quadrature of the Circle.

In *Phil. Trans.* N. 196. you will find Dr. Wallis's Quadrature of the *Testudo veliformis*. And in N. 207. the same thing is solved by Dr. Gregory, Mr. Caswell *Astr. Profess.* of Oxford, also in *Phil. Trans.* N. 217. gives a Quadrature of a Portion of the Epicycloid: and after this, in the next *Trans.*, Mr. Halley, Savilian Professor of Geometry in Oxon, advances a general Proposition for measuring all Cycloids and Epicycloids; which is this, *That the Area of any Cycloid or Epicycloid, whether Primary, Contracted or Prolate, is to the Area of the generating Circle, and the Areas of the Parts generated in the formation of those Curves, are to the Areas of the Segment of that generating Circle; as the Sum of the Double Velocity of the Centre, and of the Velocity of the Motus Circularis, is to the Velocity of that Motus Circularis.*

In *Philos. Trans.* N. 245. Mr. Craig gives us the Quadrature of the Logarithmick Curve.

In the *Memoirs de L'Academie des Sciences*, there is (in the Year 1699) a Quadrature of the Infinity of Segments, Sectors, and other Spaces in the Vulgar Cycloid by Mr. Bernoulli, Professor of Math. at Groningen.

In the *Act. Erud. Lipsiæ* for Octob. 1683, you have a Method by Mr. Tschirnhause, of determining either the Quadrature of any Geometrical Figures, or the Impossibility of the same. And in May, 1684, he published in the same *Acta* another Paper concerning the Quadrature of Curvilinear Figures.

In *Phil. Trans.* N. 284, there is a Specimen of a general Method for determining the Quadrature of Figures, by Mr. J. Craig.

And in N. 278, one of Mr. de Moivre for the squaring of some kinds of Curves, or reducing them to more simple ones. Thus, Let  $A$  be the Area of a Curve whose Abscissa is  $x$ , and its Ordinate  $Ap$   $x^m \sqrt{dx - xx}$ . Let  $B$  be the Area of a Curve whose Abscissa is the same as that of the former, but its Ordinate  $x^{m-n} \sqrt{dx - xx}$ ; Let  $\sqrt{dx - xx} = y$ , then shall  $A$  be  $=^n B$  into  $\frac{2m+1}{2m+4}$

into  $\frac{2m-1}{2m+2}$  into  $\frac{2m-3}{2m}$  into  $\frac{2m-5}{2m-2}$  into, &c.  $= P$   
 $-\frac{1}{m+2} x^{m-1} y^3 = -Q$   $\left[ \frac{d}{m+1} \text{ into } \frac{2m+1}{2m+4} x^{m-2} y^3 = \right.$   
 $-R \left] - \frac{dd}{m} \text{ into } \frac{2m+1}{2m+4} \text{ into } \frac{2m-1}{2m+2} x^{m-3} y^3 = -S,$   
 $\left[ \frac{d^3}{m-1} \text{ into } \frac{2m+1}{2m+4} \times \frac{2m-1}{2m+2} \times \frac{2m-3}{2m} x^{m-4} y^3 = -T, \&c. \right.$   

5 B b b

Where



Where observe,

1. That  $n$  is supposed to be an Integer and Affirmative Number.

2. That the Quantity  $d_n B$  in the Series designed by  $P$ , is to be multiply'd into as many of the Terms as there are Units in  $n$ .

3. That so many following Series design'd by  $-Q$ ,  $-R$ ,  $-S$ ,  $-T$ , &c. may be taken as there are Units in  $n$ .

Which to illustrate by an Example or two.

If  $n=1$ , then I say,  $A=d_n B$  into  $\frac{2m+1}{2m+4} \frac{1}{m+2} x^{m-1} y^3$ . And if  $n=2$ , then  $A=d_n B$  into  $\frac{2m+1}{2m+4} \frac{1}{m+2} x^{m-1} y^3$  into  $\frac{2m-2}{2m+2} \frac{1}{m+2} x^{m-1} y^3$  into  $\frac{d}{m+1} \frac{2m-1}{2m+4} x^{m-1} y^3$  into  $\frac{2m-3}{2} x^{m-3} y^3$ ; and putting 0 and 3 instead of  $m$  and  $n$ , it will come out thus,  $dB$  into  $-\frac{3}{2} = \frac{y^3}{x^3}$ , or  $B = \frac{2y^3}{3x^3}$ .

4. If  $y$  be equal to  $\sqrt{dx-xx}$ ; Then  $A$  will be  $=Q-R+S-T$ , &c.  $\pm P$ .

Corol. 1.

If  $m$  be put equal to any Term in the following Series  $-\frac{1}{2}, \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \frac{7}{2}, \frac{9}{2}$ , &c. The Quadrature of the Curve, whose Ordinate is  $x^m \sqrt{dx-xx}$ , or  $x^m \sqrt{dx+xx}$ , comes out finite, and is exhibited by our Series; which that we may shew by an Example: Let the Area of the Curve, whose Ordinate is  $x - \frac{1}{2} \sqrt{dx-xx}$  be to be investigated: Imagine this Curve to be compared with another, whose Ordinate is  $x - \frac{3}{2} \sqrt{dx-xx}$ . Because in this Case  $n=1$ . Therefore

$$A=d_n B \text{ into } \frac{2m+1}{2m+4} + \frac{1}{m+2} x^{m-1} y^3: \text{ But } m=-\frac{1}{2}: \text{ Wherefore } 2m+1=0; \text{ and therefore } A=-\frac{1}{m+2} x^{m-1} y^3 = -\frac{2y^3}{3\sqrt{xx}}.$$

Here it is observable that the Area, thus found, sometimes falls short of, and sometimes exceeds the true Area, by a given Quantity: And to know such Defect or Excess, the Area thus found is to be supposed encreased or diminished by a given Quantity as  $q$ ; and then supposing  $x=0$ , let the Area so increased or diminished, be supposed equal to Nothing; and so in the present Case  $q$  will be found equal to  $\frac{2}{3} d\sqrt{d}$ : And therefore,

$$A=\frac{2}{3} d\sqrt{d} - \frac{2y^3}{3\sqrt{x^3}}.$$

Corol. 2.

If  $n$  be supposed equal to any Term in the following Series, 3, 4, 6, 7, &c. the Quadrature of the Curve, whose Ordinate is  $x^n \sqrt{dx-xx}$ ; or  $x^n \sqrt{dx+xx}$ , becomes finite; and will be exhibited by our Series. Thus for Instance; let the Area of a Curve, whose Ordinate is  $x^3 \sqrt{dx-xx}$ , be sought.

Imagine it to be compared with the Area of a Circle, which call  $A$ . Then shall  $m=0$ ,  $n=3$ ; and consequently  $A=P-Q-R-S$ : But since the Quantity  $2m$ , in the Denominator of the third term, by which  $d_n B$  is multiply'd, is infinitely small, or rather nothing; the Quantity design'd by  $P$ , will be infinite; and for the same reason, the Quantity expressed by  $-S$ , is infinite also; and therefore the

Quantities  $A$ ,  $-Q$ ,  $-R$ , will vanish: Wherefore

$P=S$ ; and the Equation divided by  $\frac{2m+1}{2m+4}$  into  $\frac{2m-1}{2m+2}$  becomes  $d_n B$  into  $\frac{2m-2}{2m} \frac{dd}{m} = -x^{m-3} y^3$ : or

$d_n B$  into  $\frac{2m-3}{2} = dd x^{m-3} y^3$ ; and putting 0 and 3

instead of  $m$  and  $n$ , it will come out thus,  $dB$  into  $-\frac{3}{2} = \frac{y^3}{x^3}$ , or  $B = \frac{2y^3}{3x^3}$ .

Corol. 3.

If  $m$  be supposed equal to any Term of the following Series  $-2, -1, 0, 1, 2, 3, 4, 5$ , &c. The Quadrature of the Curve, whose Ordinate is  $x^m \sqrt{dx-xx}$  depends upon the Quadrature of the Circle: But the Area of the Curve, whose Ordinate is  $x^m \sqrt{dx+xx}$  depends upon the Quadrature of the Hyperbola; and the Relation of that Curve to either the Circle or Hyperbola will be exhibited in the Series, and in finite Terms.

Corol. 4.

If  $m$  be explained by any other Term different from those above-mentioned: Then the Curve whose Ordinate is  $x^m \sqrt{dx+xx}$ , can neither be exactly squared, nor doth it depend on either the Circle or the Hyperbola: But yet it may be reduced to a more simple Curve by our Series.

Theorem 2.

Let  $A$  be the Area of a Curve whose Abscissa is  $x$ , and Ordinate  $\frac{x^m}{\sqrt{dx-xx}}$ . And let  $B$  be the Area of a Curve whose Abscissa is also  $x$ , but its Ordinate is  $\frac{x^{m-n}}{\sqrt{dx-xx}}$ . Let  $\sqrt{dx-xx} = y$ :

Then shall  $A=d_n B$  into  $\frac{2m-1}{2m}$  into  $\frac{2m-3}{2m-2}$  into  $\frac{2m-5}{2m-4}$  into  $\frac{2m-7}{2m-6}$ , &c.  $=P$ .  $-\frac{1}{m} x^{m-1} y = -Q$ .  $\frac{d}{2m-1}$  into  $x^{m-2} y = -R$ .

$-\frac{m-1}{dd} \frac{2m-1}{2m-1} \frac{2m-3}{2m-3} x^{m-3} y = -S$ .  $\frac{m-1}{ddd} \frac{2m-1}{2m-1} \frac{2m-3}{2m-3} \frac{2m-5}{2m-5} x^{m-4} y = -T$ .

N. B. The Observations made above on Theorem 1. will be of Use here also.

Corol. 1.

If  $m$  be supposed equal to any Term in this Series  $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \frac{7}{2}, \frac{9}{2}$ , &c. Then the Quadrature of the Curve whose Ordinate is  $\frac{x^m}{\sqrt{dx+xx}}$  will be finite, and will be exhibited by this Series.

Corol. 2.



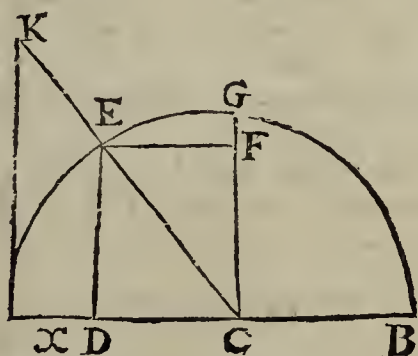
Corol. 2.

If  $n$  be supposed equal to any Term in the following Series, 1, 2, 3, 4, 5, 6, 7, &c. Every Curve whose Ordinate is  $\frac{x-n}{\sqrt{dx+xx}}$  will be squared by this Series, and come out in finite Terms.

Corol. 3.

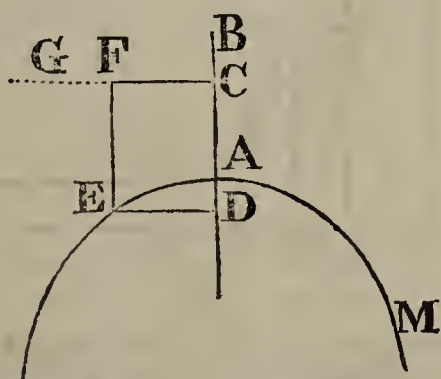
If  $m$  be equal to any Term in this Series, 0, 1, 2, 3, 4, 5, 6, 7, &c. Every Curve whose Ordinate is  $\frac{x^m}{\sqrt{dx-xx}}$  depends upon the Quadrature of the

Circle: But if the Ordinate be  $\frac{x^m}{\sqrt{dx+xx}}$ , on that of the Hyperbola: And if on the Centre  $C$ , with the Diameter  $AB=d$ , the Circle  $AEB$  be described; and  $AD=x$ , and  $DE$  erected at Right-angles, and  $CE$  drawn: Then will the Se-



ctor  $AEC$  divided by  $\frac{dd}{8}$ , be equal to the Area

of the Curve whose Ordinate is  $\frac{x^0}{\sqrt{dx-xx}}$ ; after the same Manner if on the Centre  $C$ , and the Transverse Axis  $AB=d$ , an Equilateral Hyperbola be described; as  $AE$ : Let  $AD=x$  and  $DE$  erected Normally, and  $CE$  drawn: Then shall the Se-



ctor  $ACE$  divided by  $\frac{dd}{8}$  be equal to the Area of

the Curve whose Ordinate is  $\frac{x^0}{\sqrt{dx+xx}}$ .

Corol. 4.

If  $m$  be supposed equal to any Term not included within the former Limits; The Curve whose Ordinate shall be,  $\frac{x^m}{\sqrt{dx+xx}}$  can neither be squared

exactly, nor doth it depend on either the Circle or the Hyperbola; but yet is reducible to some more simple Curve.

Theorem 3.

If  $A$  be the Area of a Curve, whose Abscissa is  $x$ , and the Ordinate  $x^m \sqrt{xx-xx}$ ; Let  $B$  be the Area of a Curve, whose Abscissa is the same  $x$ , and its Ordinate  $x^{m-2n} \sqrt{rr-xx}$ ; and suppose  $\sqrt{rr-xx}=y$ . Then shall  $A$  be equal to  $r^{2n} B$  into  $\frac{m-1}{m+2}$  into  $\frac{m-3}{m}$  into  $\frac{m-5}{m-2}$  into  $\frac{m-7}{m-4}$ , &c. =  $P$ .

$$-\frac{1}{r^r} x^{m-1} y^3 = -Q.$$

$$-\frac{m}{r^4} \text{ into } \frac{m-1}{m+2} x^{m-3} y^3 = -R.$$

$$-\frac{m-2}{m+2} \text{ into } \frac{m-3}{m} x^{m-5} y^3 = -S,$$

&c.

Corol. 1.

If  $m$  be equal to any Term of the following Series 1, 3, 5, 7, 9, &c. the Quadrature of the Curve, whose Ordinate is  $x^m \sqrt{rr+xx}$  will come out finite, and be expressed by the Theorem.

Corol. 2.

If  $n$  be equal to any Term in this Series, 2, 3, 4, 5, 6, &c. the Curve whose Ordinate is  $x^{2n} \sqrt{rr+xx}$  will be exactly squared by this Theorem.

Corol. 3.

If  $m$  be expounded by any Term different from those above-mentioned; the Curve whose Ordinate is  $x^m \sqrt{rr+xx}$  is neither exactly quadrable, nor dependant on the Circle or Hyperbola; but yet is reducible to a more simple Form.

Theorem 4.

If  $A$  be the Area of a Curve whose Abscissa is  $x$ , and its Ordinate  $\frac{x^m}{\sqrt{rr-xx}}$ ; Let  $B$  be the Area of another; whose Abscissa  $x$  is the same with the former; but its Ordinate  $\frac{x^{m-2n}}{\sqrt{rr-xx}}$ ; Then I say,

$$A = r^{2n} B \text{ into } \frac{m-1}{m} \text{ into } \frac{m-3}{m-2} \text{ into } \frac{m-5}{m-4} \text{ into } \frac{m-7}{m-6}, \text{ \&c.} = P.$$

$$-\frac{1}{r^r} x^{m-1} y = -Q.$$

$$-\frac{m}{r^4} \text{ into } \frac{m-1}{m} x^{m-1} y = -R.$$

$$-\frac{m-2}{r^4} \text{ into } \frac{m-1}{m} \text{ into } \frac{m-3}{m-2} x^{m-5} y = -S.$$

$$-\frac{m-4}{r^6} \text{ into } \frac{m-1}{m} \text{ into } \frac{m-3}{m-2} \text{ into } \frac{m-5}{m-4} x^{m-7} y = -T, \text{ \&c.}$$

&c.

Corol. 1.



## Corol. 1.

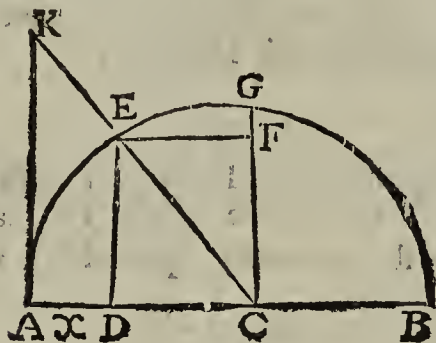
If  $m$  be equal to any Term of this Series, 1, 3, 5, 7, 9, &c. the Curve whose Ordinate is  $\frac{x^m}{\sqrt{rr+xx}}$  will be found by this Theorem in finite Terms.

## Corol. 2.

If  $n$  be equal to any Term in the following Series 1, 2, 3, 4, 5, 6, &c. The Curve whose Ordinate is  $\frac{x^{n+2n}}{\sqrt{rr+xx}}$  is exactly quadrable by this Theorem.

## Corol. 3.

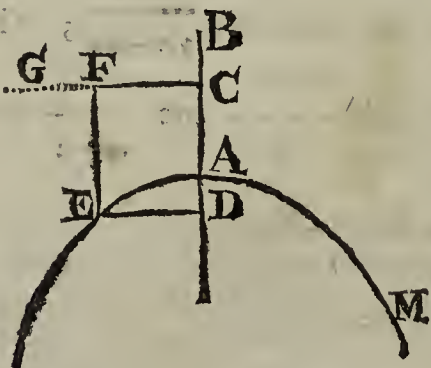
If  $m$  be equal to any Term of this Series 0, 2, 4, 6, 8, 10, &c. the Quadrature of the Curve whose Ordinate is  $\frac{x}{\sqrt{rr-xx}}$  depends upon the Quadrature of the Circle: For if from the Cen-



tre  $C$  a Circle  $AEG$  be described with the Radius  $CA=r$ ; let  $CD$  be taken equal to  $x$ , and  $DE$  erected Normally in  $D$ ; join  $CE$ . Then will the Sector  $CAE$  divided by  $\frac{1}{2}rr$ , be equal to the

Area of the Curve, whose Ordinate is  $\frac{x}{\sqrt{rr-xx}}$

And after the same Manner, if to the Centre  $C$ , the Semi-Transverse Axis  $CA=r$  an Equilateral



Hyperbola be described as  $EAM$ ; let  $FC$  be drawn at Right-angles to  $AC$ , and equal  $x$ ; then draw  $FE$  parallel to the Axis  $CA$ , till it meet the Hyperbola in  $E$ , and join  $EC$ : I say, the Hyperbolic Sector  $ACE$  divided by  $\frac{rr}{2}$  is equal to the

Area of the Curve whose Ordinate is  $\frac{x}{\sqrt{rr+xx}}$

## Corol. 4.

If  $m$  be expounded by any other Term different from any of the preceeding ones; then will the Curve whose Ordinate is  $\frac{x^m}{\sqrt{rr+xx}}$  be neither exactly squarable, nor dependant on the Circle, or Hyperbola; but yet is reducible to a more simple Form.

## Theorem 5.

Let  $A$  be the Area of the Curve whose Abscissa is  $x$ , and its Ordinate  $\frac{x^m}{d-x}$ , and let  $B$  be the Area of another Curve, having the same Abscissa  $x$ , and whose Ordinate is  $\frac{x^{m-n}}{d-x}$ ; Then shall the Area,

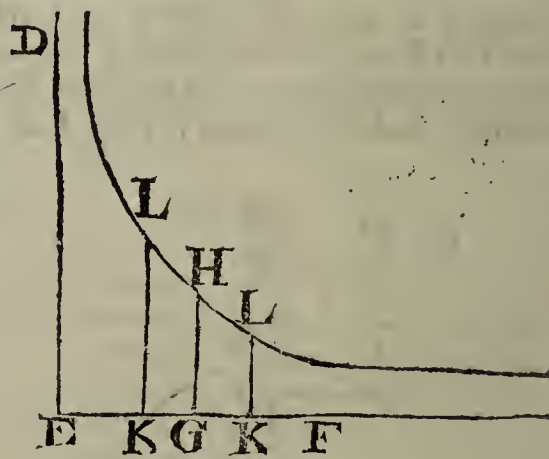
$$A = d^n B - \frac{x^m}{m} - \frac{dx^{m-1}}{m-1} - \frac{ddx^{m-2}}{m-2}, \text{ \&c. And}$$

if the Ordinate be  $\frac{x^m}{d+x}$ ; Then the Area,

$$A = \frac{x^m}{m} - \frac{dx^{m-1}}{m-1} + \frac{ddx^{m-2}}{m-2}, \text{ \&c. } + d^n B.$$

## Corollary.

If  $m$  be equal to any Term in the following Series 0, 1, 2, 3, 4, 5, 6, &c. The Quadrature of the Curve, whose Ordinate is  $\frac{x^m}{d+x}$ , depends upon the Quadrature of the Hyperbola.



For drawing  $DE$ ,  $EF$  at Right-angles, let  $EG$  be taken equal to  $d$ ; and let  $GH$  be drawn Normal and Equal to  $EF$ . Then between the Asymptotes  $DE$ ,  $EF$ , let an Hyperbola be described passing thro'  $H$ ; and taking  $GK=x$ , towards  $E$  in the first Case, and towards  $F$  in the latter, let the Ordinate  $KL$  be drawn: Then shall the Area  $HGKL$  divided by  $dd$  be equal to the Area of the Curve, whose Ordinate is  $\frac{x^0}{d+x}$ .

And from hence, supposing the Quadrature of the Hyperbola, will the Solid, generated by the Revolution of the Portion of a Cissoïd round the Diameter of the generating Circle, be given in finite Terms.

## Theor. 6.

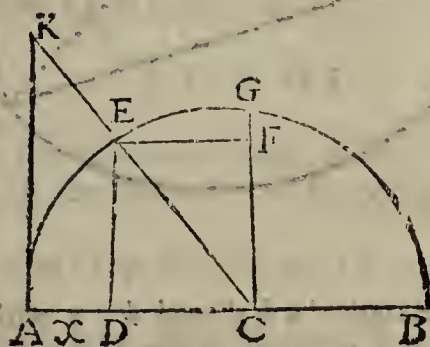


Theorem 6.

Let  $A$  be the Area of the Curve whose Abscissa is  $x$ , and Ordinate  $\frac{x^m}{rr+xx}$ ; Let  $B$  be the Area of another Curve whose Abscissa is the same  $x$ : Let its Ordin. be  $\frac{x^m 2^n}{rr+xx}$ . I say its Area  $A = \frac{x^m}{m-1}$   $-\frac{rrxm^3}{m-3} + \frac{r^2x^5}{m-5}$ , &c.  $\mp r^{2^n} B$ .

Corollary.

If  $m$  be equal to any Term in this Series 0, 2, 4, 6, 8, &c. The Quadrature of the Curve, whose Ordinate is  $\frac{x^m}{rr+xx}$ , depends upon the Rectification of the Circular Arch. For if with the Radius



$CA=r$ , and on the Centre  $C$ , the Circle  $AEG$  be described: Let the Tangent  $CK$  be erected equal to  $x$ , and join  $CK$  meeting the Periphery in  $E$ . Then I say that  $AE$  divided by  $rr$ , shall be equal to the Area of the Curve whose Ordinate is

$$\frac{x^0}{rr+xx}$$

A General Corollary to all the Theorems.

Every Mechanick Curve whose Quadrature depends on any of the infinitely many Curves, whose Ordinates put on any of the following Forms, viz.

$$\frac{x^m \sqrt{dx+xx}}{x^m}; \sqrt{\frac{dx+xx}{x^m}}; \frac{x^m \sqrt{rr+xx}}{x^m};$$

may be squared by  $\sqrt{rr+xx}$ ;  $d+x$ ;  $rr+xx$ ; this Series; as will sufficiently appear from this one Example.

Suppose the Cube of the Circular Arch corresponding to any Versed-sine be made the Ordinate of the Curve, whose Abscissa shall be that very Versed-sine: The Area of the Curve is required to be investigated.

Let the Abscissa be  $x$ , the circular Arch  $v$ ; the Fluxion of the Area is  $v^3 x$ ; Let the Area be  $v^3 x$   $-q$ . Then  $v^3 x + 3 v^2 \dot{v} x - \dot{q} = v^3 x$ ; where

$$\text{fore } \dot{q} = 3 v^2 \dot{v} x: \text{ But } \dot{v} = \frac{d x}{2 \sqrt{dx-xx}}; \text{ there}$$

$$\text{fore } \dot{q} = \frac{3 d v^2 x x}{2 \sqrt{dx-xx}} \text{ but by Theorem 2. } \frac{x r}{\sqrt{dx-xx}}$$

$$\frac{d x}{2 \sqrt{dx-xx}} - \dot{y} = \dot{v} = \dot{y}: \text{ and therefore } \dot{q} =$$

$$\frac{3}{2} d v^2 \dot{v} - \frac{3}{2} d v^2 \dot{y}; \text{ and therefore } \dot{q} = \frac{3}{2} d v^2 \dot{v} -$$

$$\frac{3}{2} d v^2 \dot{y}: \text{ Where we can find the Fluent, whose Fluxion is } \frac{3}{2} d v^2 \dot{y}. \text{ Let this Quantity be } \frac{3}{2} d v^2 \dot{y}$$

$$-r. \text{ Then } \frac{3}{2} d v^2 \dot{y} + 3 d v \dot{v} y - \dot{r} = \frac{3}{2} d v^2 \dot{y}. \text{ And therefore } \dot{r} = 3 d v \dot{v} y = \frac{3}{2} d d v x$$

$$\text{Let } r = \frac{3}{2} d d v x - s. \text{ Then } \frac{3}{2} d d v x = \frac{3}{2} d d v x + \frac{3}{2} d d x \dot{v} - \dot{s}; \text{ and consequ. } \dot{s} = \frac{3}{2} d d x \dot{v}$$

$$\frac{3 d^3 x x}{4 \sqrt{dx-xx}} = \frac{3}{4} d^3 \dot{v} - \frac{3}{4} d^3 \dot{y}; \text{ by Theor. 2. wherefore } \dot{s} = \frac{3}{4} d^3 \dot{v} - \frac{3}{4} d^3 \dot{y}; \text{ and therefore the}$$

$$\text{Area sought is } v^3 x - \frac{3}{2} d v^3 + \frac{3}{2} d v^2 y - \frac{3}{2} d d v x + \frac{3}{4} d^3 v - \frac{3}{4} d^3 y.$$

And because of Solids generated by the Rotation of Curves, the Surface is generated the same way; the Longitude of Curves, and all their Centres of Gravity, do depend on the Quadratures of Curves: These will easily be computed if they depend on the aforesaid Curves.

QUADRATUS Femoris, a Muscle of the Thigh, so called from its Figure; it ariseth broad and fleshy, from the Apophysis of the Os Ischium, and passes transversely with an equal breadth and thickness to its partly fleshy, and partly Tendinous Insertion at the Posterior part of the Os Femoris, partly below the great Trochanter. This assists the Marsupialis, in turning the Thigh-bone outwards.

QUADRATUS Genæ, Seu Tetragonus, is a great Square Muscle lying under the Skin of the Neck, and is spread over the whole inferior Region of the Face. It arises thin and membranous, from the Spines of the Vertebrae, the Skin on the Superior Part of the Cucullaris, and Pectoral Muscle, from hence ascending under the Skin of the Neck, becomes fleshy, and one part adhering to the Os Hyoides, is soon inserted to the Middle of the lower Jaw; the other broader portion proceeding farther to its Implantation in the Cheeks below the Angle of the Lips: It serves to draw down each Angle of the Mouth, together with the Cheeks, which Posture of the Face is the proper expression of Sorrow. But if the inferior Parts of these Muscles (which lie on the Neck) Act alone, they distend the Superincumbent Skin, by making it approach to a direct Line with the Clavicule and lower Jaw-bone, which otherwise is Indented according to the Formation of the Part, whereby a double Skin (as they call it) is represented.

QUADRATUS Lumborum, is a short thick fleshy Muscle, situated in the Region of the Loins, or between the last Rib and Spine of the Os Ilium; it ariseth from the Posterior part of the Spine of the Os Ilium, and is inserted to all the Transverse Processes of the Vertebrae of the Loins internally, under the Psoas Muscle. This like the Musculus Rectus Abdominis, either moves the Vertebrae of the Loins nearer the Os Ilium laterally, when we are standing on both Legs firm, or else moves the Os Ilium nearer the said Vertebrae on the contrary side, when we stand upon one Leg only.



**QUADRELS** [in *Architecture*] a kind of artificial Stones perfectly Square, made of Chalky, Whitish and Pliable Earth, &c. dried in the Shade for two Years.

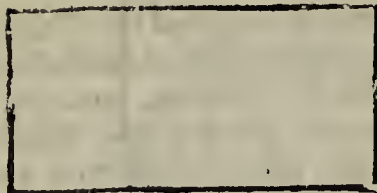
**QUADRIGEMINI**, according to some Anatomists, are four small Muscles that turn the Thigh toward the outside, and are placed upon the Articulation, or jointing of the Thigh one by another.

**QUADRILATERAL Figures**, are those whose Sides are four right Lines, and those making four Angles; and they are either *Parallelogram*, *Trapezium*, *Rectangle*, *Square*, *Rhombus*, *Rhomboides*.

*Parallelogram*, is a *Quadrilateral Figure*, whose opposite Sides are Parallel and Equal.



*Trapezium*, is a *Quadrilateral Figure*, whose Sides are unequal, as in the Figure.



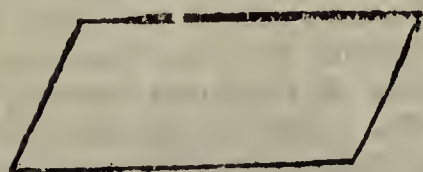
*Rectangle*, is a *Parallelogram* whose four Angles are Right, and is also called a *Rect-angled Parallelogram*.



*Square*, is a *Quadrilateral Figure* having its Angles Right, and the Sides all Parallel and Equal, as in the Figure.



*Rhombus*, is a *Parallelogram*, having its opposite Angles, and all its Sides equal, as in this Figure.



*Rhomboides*, is a *Parallelogram*, having neither its Angles nor Sides all equal.

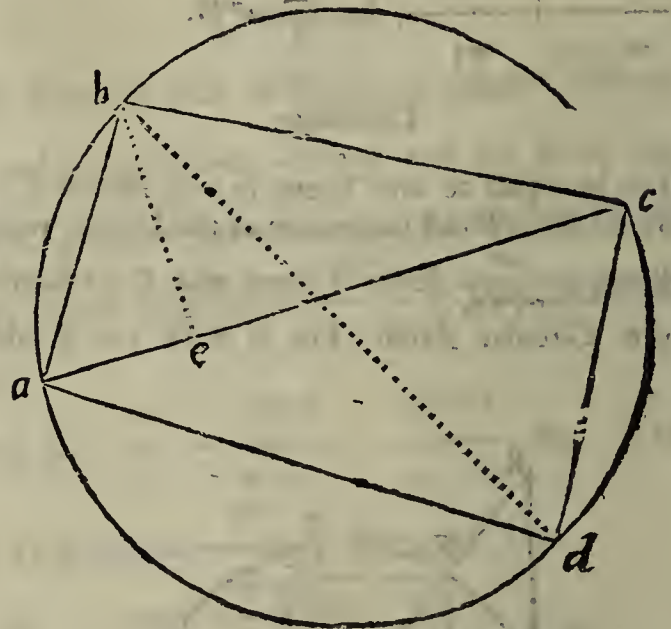
### PROPOSITION.

In a *Quadrilateral Figure* inscribed in a Circle (as  $a b c d$ ) the Rectangle under the two Diago-

nals ( $a c$  and  $b d$ ) is equal to both the Rectangles made by the opposite Sides of the Figures  $a b \times c d$ , and  $b c \times a d$ .

That is,  $a c \times b d = b c \times a d + b a \times c d$ . Make the Angle  $a b e = \angle c b d$ .

### DEMONSTRATION.



1. The Triangles  $a b d$  and  $b c e$  will be similar; for  $\angle b d a$  is equal to the  $\angle b c a$ , (being in the same Segment) and the  $\angle a b d = \angle e b c$ , by the Addition of the common Angle  $e b d$ , to the two equal ones  $a b e$  and  $d b c$ .

Then will  $b c : c e :: b d : d a$ . and consequently  $b c \times d a = c e \times b d$ . That is, the Rectangle under the opposite Sides  $a d$  and  $b c$ , is equal to the Segment  $e c$  multiplied by the Diagonal  $b d$ .

2. The Triangles  $a b e$  and  $c b d$  are Similar, because the  $\angle a b e = \angle c b d$  (by construction) and the  $\angle b a e = \angle b d c$ , being in the same Segment.

Therefore  $a e : a b :: c d : b d$ .

Consequently  $a c \times b d = a b \times c d$ . That is, the  $\square$  under the remainig Segment  $a e$ , and the former Diagonal  $b d = \square$  under the opposite sides  $a b$  and  $c d$ .

But  $a c = a e + c e$ .

Wherefore  $a c \times b d = b c \times a d + d c \times a b$ .

Q. E. D.

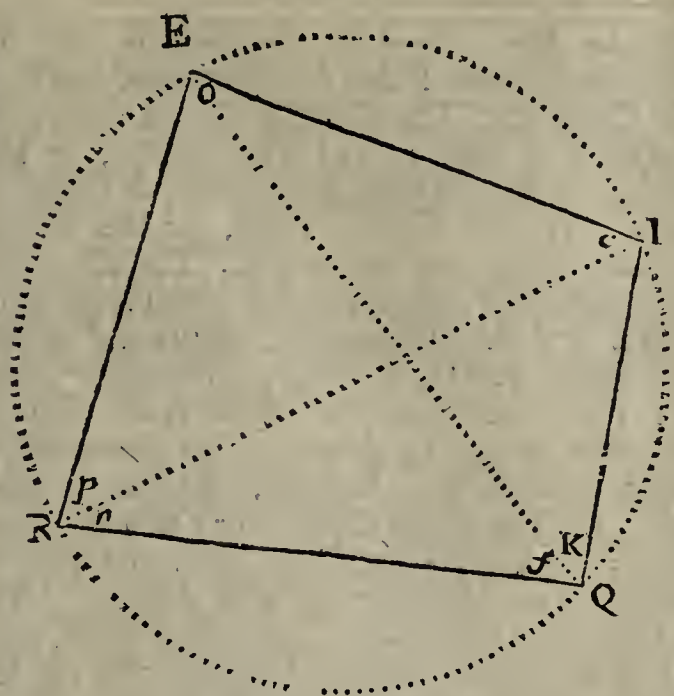
### PROPOSITION.

The opposite Angles of any *Quadrilateral Figure* Inscribed in a Circle, are always equal to two right ones.

I say  $O + k + f = 2 \angle$ . Draw the Lines  $R I$  and  $E Q$ .

The





The Angles  $O + p + c = 2 \angle$ , by the 32 e. 1.

But  $\angle p = \angle k$ , and  $\angle c = \angle f$  per 21. e. 3.

Therefore  $O + K + f = 2 \angle$ . q. e. d.

### C O R O L.

Hence the external Angle of such a Figure, as  $E = k + f$ , the Internal and Opposite one.

For  $O + c = 2 \angle = O + k + f$ .

Therefore take away  $O$  from both, and  $E$  will remain equal to  $k + f$ , q. e. d.

QUADRIPARTITION, is to divide by 4, or to take the fourth Part of any Number or Quantity.

QUADRUPEDS, are perfect hairy Viviparous Animals, having but four Feet. And these Animals according to Mr. Ray in his *Synopsis Animalium* are thus divided.

Into such as are Hoofed (*Ungulata*;) or Clawed, or Digitate (*Unguiculata*.)

(1) The Hoofed Animals with four Feet, are either Whole Hoofed; *Solidipeda*, *Μονόχλα Μόνυχα Solidungula*: As, The Horse, Ass, the Onager, or Wild Ass: The Mule and the Zebra of Africa, or the fine striped Indian or African Ass, almost like a Mule in Form and Stature.

Of this Whole Hoofed Kind, Aristotle has observed; that no one hath two Horns, (he might have said any) no one hath the Talus or Astragalus; nor have the Males any appearance of Breasts.

(2) Cloven-footed; and that either into Two Divisions only: As the *ιππο* or Bifurcate Kind, which are again subdivided into such as are

1. Ruminant, *Μρυγάζοντα*, i. e. Such as Chew the Cud; and these either have hollow and perpetual Horns as the Ox, Sheep, and Goat Kind: Or Deciduous, as the Hart and Deer Kind; which usually shed their Horns annually. (See Ruminant)

Of the Bull Kind, they reckoned these: The common Bos; of which the Male is *Taurus*, the Female *Vacca*: (2) The German *Urus*, *Urochs*, or *Aurochi*, (3) The Bison, (4) The Bonasus, (5) The Bubalus, or Buffalo, (6) The Bos Africanus of Bellonius; Obs. l. 2. c. 50. which he takes to be the Bubalus of the Ancients.

Of the Sheep Kind; besides the common Sort; they reckon. (2) The Arabian *Ovis Laticauda*, whose Tails sometimes are of 30l. Weight: (3) The

*Ovis Strepsiceros Cretica Bellonii*: (4) The *Ovis Africana*, with short Hairs instead of Wool, (5) The *Ovis Guineensis*, or *Angolensis* of Marcgrave, (Hist. Brasil. l. 6. c. 15.)

Of the Goat Kind, are besides the common *Capra domestica*; (2) The Ibex, or German Steinbeck; found in the Tops of the Alps. (3) The *Rupicapra*, French Chamois, German Goms. (4) The *Gazella Africana*, or Antelope. (5) The *Gazella Indica*. (6) The *Gazella Africana*. (7) The *Capra Sylvestris Africana Grimmii*. (8) The *Capra Mambrina* or *Syriaca* of Gesner. (9) The *Buselaphus* or *Moschelaphus Carii*, in Gesner. (10) The *Tragelaphus Carii*, in Gesner. (11) The *Tragelaphus Bellonii*.

Of the Hart or Deer Kind: As, (1) The *Cervus*, *Ἐλαφος*, the Red Deer. (2) The *Cervus Platyceros* or *Palmatus*; the Falloze Deer. (3) *Alce* or the Elk. (4) *Rangifer*, the Rain Deer. (5) The *Axis Plinii*, according to Bellonius. (6) The *Caprea Plinii*. (7) The *Cugiacu-etc* and *Cugiacu-zapara* of Marcgrave. (8) The *Caprea Groenlandica*.

2. Of the Cloven-footed Animals into Two Parts only, and which do not chew the Cud: There is only the Hog and Swine Kind; and under this Head, besides the common Swine; they reckon, (2) The Wild Boar or Swine. (3) The *Porcus Guineensis Marcgravii*. (4) The *Porcus Indicus*, called *Babyroussa*. (5) The *Tajaca* or *Aper Mexicanus Moschiferus* of Dr. Tyson, called by Marcgrave *Tajaca Cunigoara*; by others *Quauhtla Coymalt* and *Quapizotl*; and by Acofta and some others, *Zaino*. See a most accurate Description of this Animal, in *Philos. Transf. N. 153*.

3. There are some Four-footed Animals whose Hoof is cloven into Four Divisions; and these seem to be not Ruminantes As the *Rhinoceros*, the *Hippopotamus*, the *Tapijerete* of Brasile, the *Capy-Bara* of Brasile, the *Animal Moschiferum*.

II. Clawed or Digitate (*Unguiculata*) Four footed Animals. Of this kind there is one Sort whose Claws are not divided or separated, but adhering one to another, covered with one common Skin, but with obtuse Nails sticking out round the Margin of the Foot; as the Elephant, which is anomalous, and not clearly referable to this Kind, or that of Cloven footed Quadrupeds.

(2) There is another Species of this Digitate Kind of Quadrupeds, which hath only two Claws, as that of Camels; and tho' these have no Horns, they do both Ruminant; and have also the four Stomachs of Horned Ruminant Animals.

Of the Camel, or Dromedary, there are two Sorts; one having but one Bunch on the Back, the other two. To this Kind belongs the Peruvian Glama, which some have reckoned among the Sheep-kind. As also the Pacos, the *Ovis Indica* or *Peruviana vulgo*, much less than the Glama.

3. A third Species of this Unguiculate Kind of Quadrupeds includes such Animals as the Greeks called *Πλασιώνυχα*, and *Ἀνθρωπόμορφα*; which have the Foot divided into many Claws with broad Nails on them: As the Ape and Monkey Kind. Of these some have no Tails, and are called *Simie* or *Apes*, Others have Tails, and are called *Monkeys*, *Cercopithecii*; and such as have either long or short Tails, if they are of a large size, are called *Papiones* or *Baboons*. There are great Numbers and Varieties of their Species of Quadrupeds; of which Naturalists have described these. (1) The *Ourang-Outang*, or *Homo Sylvestris* of Dr. Tyson, described by him in a particular Discourse. (2) The *Guari-*



ra of *Brasile*, *Marcgravii*. (3) The *Cagni* of *Brasile*, greater and lesser. (3) The *Cay* of the same Region, described by *Lerius*. (5) The *Caitaia* of the same Country. (9) The *Cercopithecus Angolensis major*. (7) The *Cercopithecus Barbatu Guineensis*, 2 or 3 Sorts of it. (8) The *Cercopithecus non Barbatu Clusii*. (9) *Cercopithecus Clus.* called *Sagonin*; and, if Apes and Monkeys have their Snouts very prominent like Dogs, they are called *Cynocephali*.

4. A fourth Species of this Unguiculate Kind of Quadrupeds is, when though the Claws are many, yet they are not covered at the Ends with broad flat Nails, like Monkeys or Apes; but are rather like the Talons of Hawks, &c. Crooked and Sharp pointed. And these in respect of their Teeth may be divided into such as have many *Dentes Primores, aut Incisores*, (i. e. cutting Teeth) in each Jaw; of which there are two Sorts, a Greater, which either have a short round Head, as the *Cat* kind; or a longish Snout as the *Dog* kind; or a Lesser Sort; having a long slender Body with very short Legs, as the *Weasel* or *Vermine Kind*. There are some of this Species of Quadrupeds, which have only Two large remarkable Teeth in each Jaw; and these are of the *Hare Kind*, and live only upon Herbs, Grass, &c.

Of the *Cat-kind* of Quadrupeds they reckon to be (1) The *Lion*, (2) The *Tiger*, (3) The *Pardalis*, whose Male is *Pardus* Female *Panthera*, The *Leopard*. (4) The *Lupus Cervarius* or *Lynx*. (5) The *Catus Pardus* or *Cat-a-mountain*. (6) The common *Cat*. (7) The *Bear*.

Of the *Dog-kind* they account, (1) The *Wolf*, (2) *Lupus Aureus* the *Jackall*, (3) The common *Dog*. Of which kind they enumarate; (1) The *Mastive*, (2) The *Canis Venaticus Graius* or *Græcus*; or according to some *Scoticus*, the *Grey-hound*. (4) The *Canis Venaticus Sagax*, *Indagator*, *Seſtator ferarum*, &c. the *Hound*. (5) The *Canis Venaticus Hispanicus* or *aviarius*: The *Spaniel* for Land or Water. (6) The *Vertagus* or *Tumbler*. (7) The *Canis Oxygus*, *Domesticus*, the *Houſe-dog*. (8) The *Canis Melitæus* or *Lap dog*. (9) The *Canis Getulus* or *Islandicus*; the *Shock*: And of all these Sorts there are many Varieties of *Mongrels* and *Hebrious Breeds*.

Another Sort of the *Dog-kind* is (4) The *Fox*. (5) The *Animal Zibethicum*, the *Civet-Cat*, as 'tis corruptly called; but by its Teeth and Snout is plainly of the *Dog-Tribe*. (6) The *American Coati*, or *Rackoon* or *Rattoon*. (7) The *Tzquiepaté*. (8) The *Carigucya*, *Maritucaca*, *Carigoy*, *Ropoza*, or *Poſſum*. (9) The *Taxus*, or *Meles*. The *Badger Grey*, or *Pate* (in the North) (10) The *Lutra* or *Otter*. (11) The *Phoca* or *Sea-Calf*, or *Seal*. (12) The *Equus Marinus*, or *Morſe*, or *Sea-Horſe*, miſtaken by ſome for the *Hippopotamus*. The *Dutch* call him *Walrai*; the *Danes* and *Iſlanders*, *Rofmarus*. (13) *Manati ſeu Vacca Marina*; the *Sea-Cow*.

Of the *Vermine* or *Weeſel-kind* of Quadrupeds, is firſt, The *Mustela vulgaris* the *Weeſel*; in *Yorkſhire*, *Foumart* or *Fitchet*, (*γαλέν*) (2) *Viverra Indica*, called *Quel* and *Quirpele*; and another Sort called *Mungo* and *Mungarbia* of a reddiſh Grey. (3) The *Mustela*, the *Ermine* or *Stoat*, if white; and the *Mustela Sylveſtris*, the *Ferret*. (4) *Putorius*, the *Pole-cat*, (5) *Martes*, *Foyna* (whence our word, a *Gozen* of *Foins*) the *Marten* or *Martlet*. (6) *Mustela Zibellina*, the *Sable*. (7) The *Genetta*. (8) The *Ichneumon Bellonii*.

Of the *Hare Kind* of Quadrupeds, are firſt *Lepus*, the common *Hare*: (2) *Cuniculus*, the *Rabbit* or *Coney*. (3) The *Tapeti* or *Brasile Coney*, and the *Aperea* of *Brasile*. (4) The *Hystrix*, or *Porcupine*; and the *Hystrix Americanus*, or *Cuanda* of *Brasile*. (5) The *Caſtor*, *Fiber*, or the *Beaver*. (6) The *Sciurus vulg.* or *Squirrel*. The *Virginian*, *Zeylandick*, the *Barbary*, the *American Flying Squirrel*, &c. (7) *Mus Domesticus*, *Major* and *Minor*: The common *Ratt* and *Mouse*; *Mus major Aquaticus*, the *Water-Rat*, the *Musk Rat*. *Mus Avellanarum Major* & *Minor*. The *Dormouse* or *Sleeper*, *Mus Noricus*, *Cricetus*, *Alpinus ſeu Marmotta*. (7) The *Cavia Cobaya*, or *Cuniculus Americanus*; the *Guinea Pig*: The *Agati* and *Paea* of *Brasile*: The *Mus Norwegicus* or *Leming*: The *Glis Gefneri* or the *Roll*: The *Mus Indicus*, &c.

To theſe ſeveral Kinds of Quadrupeds the following Anomalous one muſt alſo be added;

1. Such Four-footed Viviparous Animals as have a longiſh Snout; with their Feet divided into many Claws or Toes, and having Teeth; as (1) the *Echinus Terreſtris*, or common *Urchin* or *Hedge-hog*. (2) The *Erinaceus Indicus albus*. *Cat. Muſ. Leyden*. (3) The *Tatu* or *Armadillo prima* of *Marcgrave*. (4) The *Tatuete* of *Brasile*; or the ſecond Species of the *Armadillo*, according to *Marcgrave*. (5) *Tatu Apra*; his third Species of the *Armadillo*. (6) *Tatu Mustelinus*, *Soc. Reg. Muſ.* The *Weeſel* headed *Armadillo*. (7) *Talpa*, the *Mole*, *Want*, or *Moldwarp*. (8) The *Mus Araneus*, *Shrew*, *hardy Shrew*, *Shrew mouse*.

2. Quadrupedous and Viviparous Animals with a longiſh Snout, having their Feet divided into many Claws or Toes, but without Teeth, are theſe:

(1.) The *Tamandua-guacu* of *Brasile*, *Marcgr.* *Urfus Formicarius Cardani*; the great *Ant-Bear*. (2) The *Tamanduais* of *Brasile*, or *Marcgrave's* leſſer *Ant-Bear*.

3. Anomalous Flying Quadrupeds with a ſhorter Snout, with their Feet divided as above, and are the *Bat-kind* or *Flutter-mice*: Of which there are ſeveral Sizes, and different Forms.

4. There is one very odd anomalous Animal, which hath but 3 Claws on each Foot; and that is the *Aſs*, or *Ignavus* of *Marcgrave*; the *Sloth* or *Sluggard*.

5. Viviparous and Sanguineous Quadrupeds breathing with Lungs, but having only one Ventricle in the Heart, are Theſe. (1) *Rana aquatica*, the *Frog*, or *Froſh*. *Rana Arborea ſeu Ranunculus Viridis*, the ſmall Tree or green Frog. (2) *Bufo*, ſive *Rubeta* the *Toad*. (3) *Teſtudo*, the *Tortoiſe*, *Gr. χελών*; of theſe there are Land and Water ones; and many different Species in Foreign Parts.

6. Oviparous Quadrupeds with a long Tail, ſtretcht out horizontally; are the *Lizard Kind*: As (1) *Lacertus omnium Maximus*; The *Crocodile*. (2) *Cordylus*, ſive *Caudi-verbera*, *Uromastix Græcis*, larger than the green Lizard. (2) *Tapayaxin Novæ Hiſpaniæ*. The *Lacertus Orbicularis* of *Hernandez*, *Ch. 9. c. 16*. *Lacertus Vulgaris*, the common *Eft*, *Swift*, or *Newt*, (4) *Lacertus Viridis*, the green Lizard (5) *Lacertus Fucetanus Aldrovand*; at *Rome* and *Naples* called *Tarantola*. (6) *Lacertus Indicus*; called *Senemby*, and *Inguana*. (7) *Lacertus Braſiliensis*, called *Tejuguacu* and *Temapara*, by *Marcgrave* (8) The *Taraguira*, *Ameira*, *Taraguico Aycuraba*, *Americima*, *Curapopepa*, *Teiunkana*, &c. of *Marcgrave*; the *Lacertus Indicus*,



cus, &c. (9) *Scincus*, seu *Crocodilus*, *Terrestris*. (10) *Sepe*, five *Lacerta Chocidica*, a Kind of footed Serpent. (11) *Stellio*, the swift or spotted Lizard. (12) *Salamandra Terrestris*, *Salamandra Aquatica*, the Water Eft. (13) *Lacerta volans Indica*. (14) *Chamaleo*, the Chamelion.

**QUADRUGATA** *Terre* [*old Records*] a Team Land, or so much as can be tilled by Four Horses.

**QUADRUPLE** [*Quadruplex* is] a Sum or Number multiply'd by 4, or taken four times, four-fold.

**QUÆ Plura**, was a Writ that lay where an Inquisition had been made by an Escheator, in any County, of such Lands or Tenements as any Man died seized of, and all that was in his Possession, was imagined not to be found by the Office: It differs from the Writ called *Melius Inquirendum*, because this is granted, where the Escheator formerly proceeded by Virtue of his Office; and the other, where he found the first Office by virtue of the Writ named *Dium clausit extremum*.

**QUÆ Servitia**; see *Per quæ Servitia*.

**QUÆRENS** *non invenit Plegium*, in the Law, is a Return made by the Sheriff on a Writ directed him, with this condition inserted. *Si A fecerit B Secutum de Clamore*, &c.

**QUÆSTUS** } [*in Law*] that Estate or those Effects which a Man hath, either by acquisition or purchase in Contradistinction to *Hereditas*, which is what he hath by Descent.

**QUÆSTA**, was the Term for an Indulgence or Remission of Penance, exposed to Sale by the Popes; who by this notorious Cheat got great Sums: The Retailers of these Indulgences, were called *Quæstuarii*, and I believe *Quæstionarii*, vid. *Matt. West.* in Anno. 1279.

**QUALE jus**, is a Writ judicial, that lies where a Man of Religion hath Judgment to recover Land, before Execution be made of the Judgment; for this Writ must go forth to the Escheator, between Judgment and Execution, to enquire whether the Religious Persons hath any Right to recover, or whether the Judgment be obtained by Collusion between the Demandant and the Tenant, to the intent that the true Lord be not defrauded.

**QUALIFCTOR** [*in the Canon Law*] a Divine appointed to qualify or declare the Quality of a Proposition, that is brought before an Ecclesiastical Tribunal; especially before the Inquisition.

**QUALITY**, signifies in the general the Properties or Affections of any Being, whereby it effects our Senses so and so, and acquires such and such a Denomination.

The Four *First Qualities*, as they are accounted by some, are *Heat*, *Cold*, *Moisture*, and *Dryness*.

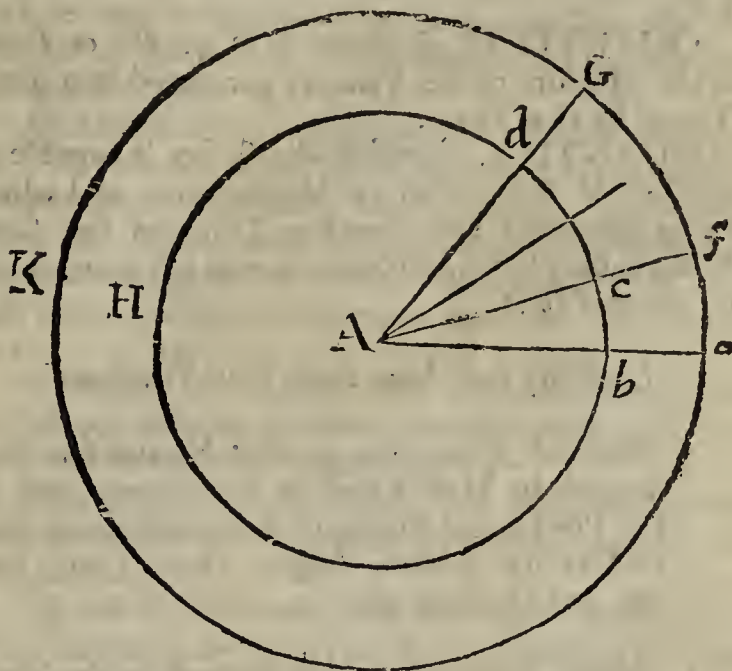
The Four *Second Qualities*, or as they may be called, Chymical Qualities, are Volatility and Fixity, Corrosiveness and Corrosibility.

*Sensible Qualities*, are such as are the more Immediate Objects of our Senses.

*Occult Qualities*, were by the Ancients named such, of which no rational Solution in their way, or according to their Principles, could be given.

Mr. *John Keill*, in his *Introductio ad Physicam*, thus proves that all Qualities are Remitted, or have their Power or Efficacy abated, in a *Duplicate Ratio*

of the distance from the Centre of the *Radiation*, or Exertion of the Quality.



Let A be the Centre from whence any Quality exerts it self round about, according to the right Lines A e, A f, A G, &c. The Efficacy of the Quality, be it Heat, Cold, Odour, &c. will be (at equal Distances from A) as the *Spissitude* or Thickness of the Rays A b, A e, A f. But the Rays within the Inner Circle, or rather Spherical Superficies b c d H, when they come to be extended to the outer Spherical Surface, e f G K, will be much less thick than before; and that in proportion *reciprocally*, as the Spaces they take up: That is, if the outer Surface be double of the inner, the Rays there will be but half as thick: But since Spherical Superficies are as the Squares of their Radij, therefore the Efficacy of the Quality in the inner Surface will be to that of the outer, as A e Square to A b Square. q. e. d.

**Primary QUALITIES** } Are such as are found in all Bodies or which agree to all Matter considered as Matter, and therefore to the Elements themselves, as *Extension*, *Motion*, *Figure*, *Rest*, *Solidity*, *Impenetrability* and *Number*.

**Secondary QUALITIES** } Are such as result from a Composition or Mixture of Elements, and do not agree to a Body as a Body, but as a Mixt—— such are *Light*, *Heat*, *Cold*, *Colour*, *Sound*, *Taste*, *Smell*, *Hardness*, *Softness*, *Fluidity*, *Firmness*, *Roughness*, *Smoothness*, *Opacity*, *Transparency*, &c.

**Active QUALITIES** [*with Schoolmen*] are such by Virtue of which Effects and Operations are actually produced on other Bodies duly dispos'd with Respect thereto —— As the *Heat* of Fire, the *Moisture* of Water, &c.

**Passive QUALITIES** [*with Schoolmen*] are such whereby Bodies are dispos'd to receive the Actions of others —— as inflammability in Oil &c.

**Real QUALITIES** [*with Schoolmen*] are such as remain in the Subject, and only act on Things adjacent thereto, —— as Fire in a Piece of ignited Iron.

**Intentional QUALITIES** [*with Schoolmen*] are such as issue from the Subject, and operate at a distance —— as the Light emitted from the Sun.

**QUAM diu se bene gesserint**, is a Clause often used in Letters-Patent of the Grant of Offices, as in those of the *Barons* of the *Exchequer*, which  
; D d d must



must be intended only to Matters concerning their Office; and is nothing but what the Law would have implied, if the Office had been granted for Life.

**QUANTITAS** *Acceleratrix* of any *Vis* or *Force*. is the Measure of the Velocity generated in a given Time, by that Force.

**QUANTITY**, signifies whatsoever is capable of any sort of Estimation or Mensuration, and which being compared with another Thing of the same Nature, may be said to be *greater* or *less* than, *equal* or *unequal* to it.

Quantity may have these Four Divisions.

1. *Natural Quantity*, is what Nature furnishes us with in Matter and its Extensions, and in the Powers and Forces of natural Bodies; such as Gravity Motion, Light, Heat, Cold, Rarity and Density, &c.
2. *Moral Quantity*, which depends on the Manners of Men, and the free Determination of their Wills; as the Prizes and Values of Things, Dignity and Power, Good and Evil, Merit and Demerit, Rewards and Punishments, &c.
3. *Notional Quantity*, arising from the Operation of Understanding only; such as the Largeness or Narrowness of the Mind's Capacity, and of its Conceptions: In Logick, *Universals*, *Prædicaments*, and all such Terms: In Grammar, the *Quantity* and *Measure* of *Syllables*, *Accents*, *Tones*, &c.
4. *Transcendental Quantity*, as Duration, the Continuation of any Being's Existence, Time, &c. Quantity is divided also into *Continued* and *Discrete*, which see.

*Discreet* **QUANTITY** is when the Parts of which it consists exist distinctly and unconnected together; which makes what we call Number.

*Continued* **QUANTITY** is when the Parts are connected together, and is either *permanent* and *proper* as *Space*, or *Successive* and *improper* as *Time*.

**QUANTITY** of *intire Motion* [with the *Cartesi-ans*] is the same with the Momentary one, by the *Factum* of the Mass or *Quantity* of Matter into the Velocity; But in as much as Motion is a Successive Being, having no Parts Coexisting together, the *Quantity* of it ought to be estimated by the Aggregate of the several Parts existing Successively; and is therefore equal to the *Factum* of the Momenta into Time.

Hence in a Body which is twice as great as another, and is moved with an equal Velocity, the Quantity of Motion is double; and if the Velocity be double also, the Quantity of the Motion will be Quadruple. Hence the *Quantity* of Momentary Motion coincides with what we call *Momentum* or the *Impetus* of a moving Body.

In the Collision of Bodies, the *Quantity* of Momentary Motion, which is found by taking the Sum of Motions, tending the same Way, or their difference if they tend towards contrary Parts; is not all changed by any Action of the Bodies one on another.

**QUANTITIES** [in *Algebra*] are indeterminate Numbers or Things referr'd to Unity in the General,

*Algebra* being wholly Conversant in the Computation of such Quantities, they are properly the Subjects of *Algebra*.

The given Quantities are usually noted by the first Letters of the Alphabet, *a. b. c. d. &c.* and the Quantities sought by the last, *z. w. y. v.* and these Quantities are of two Kinds, Positive and Negative.

*Positive* or *Affirmative* **QUANTITIES** are such as are greater than nothing; and which are affected with the Sign  $+$  prefixed; or supposed to be so.

*Negative* or *Privative* **QUANTITIES** are such as are less than nothing; which are affected with the Sign  $-$  prefixed or added *r. q.* of Ch.

If a *Positive* **QUANTITY** be multiplied or divided by a Positive Quantity, the Result will be a Positive Quantity.

If a *Negative* **QUANTITY** be multiplied or divided by a *Negative* Quantity, the Result will be a Positive.

If a *Positive* **QUANTITY** be multiplied or divided by a *Negative*, the Result will be a Negative Quantity.

If a *Negative* **QUANTITY** be multiplied or divided by another *Negative*, the Result will be a Positive.

**QUANTITY** [in *Grammar*] is the Measure or Magnitude of the Syllables, or that which determines them to be called long or short.

The **QUANTITY** of Matter in any Body, is its Measure arising from the joint Consideration of its Magnitude and Density: As if a Body be twice as Dense, and take up twice as much Space as another, it will be four Times as great. And this Quantity of Matter is best discoverable by the Weight of Bodies, which Sir *Is. Newton* found by his Nice Experiments on Pendulums, so exactly proportional to the Matter of Bodies. *Newton. Princip.*

The **QUANTITY** of Motion in any Body, is its Measure arising from the joint Consideration of the Quantity of Matter in, and the Velocity of the Motion of that Body. For the Motion of any Whole is the Sum or Aggregate of the Motion in all the several Parts: And tho' in a Body twice as great as another, moved with an equal Velocity, it will be double; yet if the Velocity be double also, the Quantity of the Motion will be Quadruple. *Newton Princip.*

In *Philosophical Transactions*, Numb. 195. is an Account by the Learned Captain *Halley*, of the several Species, or Kinds of *Infinite Quantity*.

Where he proves, That besides *Infinite Length*, and *Infinite Area*, in which there are great Varieties;

There are also no less than three sorts of *Infinite Solidity*. See *Infinite Quantities*.

**QUANTITY** of Motion: Sir *Is. Newton* in his *Principia*, shews that this, which is found by taking the Summ of Motions tending the same Way, on their *Difference*, if they tend towards contrary Parts; is not at all changed by the Action of Bodies on one another.

For *Action* and *Re-action* are always equal and contrary, by his *Third Law* of Nature: And therefore by the *Second Law*, must make Equal Mutations in Motions towards contrary Parts.

If therefore the Motions tend the same Way, whatever is added to the proceeding Body, or that struck forward, is subducted from the following Body; so that the Summ of the Motions will be the



the same as before. If the Bodies meet, there will be an *Equal Subduction* of the Motion of either: And therefore the *Difference* of the Motion made towards the contrary Parts, will remain the same.

As suppose a Spherical Body *A*, to be thrice as great as the Spherical one *B*; and let *A* have *Two* Degrees of Velocity any way, and let *B* follow it in the same right Line with *Ten* Degrees of Velocity: So that the Motion of *A*, to that of *B*, will be as Six ( $3 \times 2$ ) to Ten. Wherefore the *Summ* of the Motions of both of them will be  $6 + 10$ , or sixteen Parts. Now after *B* hath overtaken *A*, and struck against it, if *A* gain by the Stroke any Degree of Motion, as suppose 3, 4 or 5 Parts; *B* must lose as much: And therefore after the *Concourse*, *A* will move on accordingly with 9, 10, or 11; and *B* will follow with 7, 6, or 5 Parts: So that the Summ of the Motions of both, will be still 16 as at first before the *Concourse*, or Shock.

But if the Body *A* be supposed to gain by the Stroke 9, 10, 11, or 12 Parts of Motion; and therefore to move forward with 15, 16, 17, or 18 Parts, after the *Concourse*: Then will the Body *B*, by losing just so many Degrees as *A* gains, either move forward, with one Part, having lost 9; or will be perfectly at rest, losing all its 10 Degrees of Velocity; or lastly will move backwards with one or two Parts of Motion: So much being deducted out of the 11, or 12 Parts of the Progressive Motion, or forwards. And thus the *Summs* of the Motions the same Way forward; as  $15 + 1$ , or  $16 + 0$ . And the *Differences* of the Motions contrary Ways; as  $17 - 1$ , or  $18 - 2$ ; will also be the same, viz. = 16 Parts, as before *Concourse* and *Reflection*. And the Motions with which Bodies go on after *Reflection* being known, the *Velocity* of Each may be found; by supposing *That* to be to the Velocity before the *Reflection*: as the Motion afterwards to the Motion before. Thus in the last Case, where the Body *A* had six Parts of Motion before the *Reflection*, and 18 afterwards; and the Velocity of two Parts before the *Reflection*: Its Velocity after the *Reflection* will be found to be Six; by saying, as the Motion of six Parts before the *Reflection*, to *That* of 18 afterwards: So is the Velocity of two Parts before, to that of Six afterwards.

QUANTUM *Meruit*, is an Action of the Case so called, grounded upon a Promise to pay a Man for doing any Thing, so much as he should Deserve, or *Merit*.

QUARE *ejecit infra terminum*; is a Writ that lieth for a Lessee, where he is cast out of his Farm, before his Term be expired, against the Feoffee or Lessor that ejecteth him: And it differs from *Ejectione firme*, because this lieth where the Lessor, after the Lease made, infeoffeth another, which ejecteth the Lessee: And the *Ejectione firme*, lieth against any other Stranger that ejects him. But the Effect of Both is all one; that is, to recover the residue of the Term.

QUARE *Impedit*, is a Writ that lies for him that hath purchased a Manor with an Advowson thereto belonging, against him that disturbs him in the Right of his Advowson, by presenting a Clerk thereto, when the Church is void: And it differs from the Writ called, a *Darrein presentment*, *Assisa ultimæ presentationis*, because that lies where a Man, or his Ancestors formerly presented: and this for him that is the Purchaser himself: Note, That where a Man may have an *Assise Darrein Presentment*, he may have a *Quare impedit*, but not contrariwise.

QUARE *Incumbavit*, is a Writ that lieth against the Bishop who within six Months, after the Vacation of a Benefice, conferreth it upon his Clerk, while two others are contending in Law for the Right of Presenting. This Writ always lies depending the Plea.

QUARE *intrusit Matrimonio non satisfacto*, is a Writ that lies where the Lord proffers convenient Marriage to his Ward, and he refuses, and enters into the Land, and Marries himself to another; then the Lord shall have this Writ against him. But all the Wardships being taken away by the Statute 12 Car. 2. cap. 24. this Writ is become useless.

QUARE *non admittit*, is a Writ that lies against a Bishop, refusing to admit his Clerk that hath recovered in a Plea of *Advowson*.

QUARE *non permittit*, is a Writ that lies for one that has Right to present for a Turn, against the Proprietary.

QUARE *obstruxit*, is a Writ that lies for him who having Liberty to pass through his Neighbours Ground, cannot enjoy his Right, for that the Owner has so Strengthened it.

QUARENTINA *habenda*, is a Writ that lies for a Widow to enjoy her *Quarentine*.

QUARENTINE, is a Benefit allowed by the Law of England, to the Widow of a Man Dying Seized of Land; whereby she may challenge to continue in his Capital Messuage or chief Mansion-house (so it be not a Castle) by the Space of Forty Days after his Decease; and if the Heir, or any other attempt to eject her, she may have the Writ *de quarentina habenda*.

QUARENTINE also signifies a Furlong, from the French *Quarante*, Forty: Because tis a Quantity of Land containing 40 Perches. 'Tis used also for that Space of forty Days, wherein any Person coming from Foreign Parts, and infected with the Plague, is not permitted to Land, or come on Shore, till that Term is expired.

QUARREL, in the Law is *Querela*, à *querendo*: And it extends not only to Actions personal, but also to mixt; and the Plaintiff is then called *Querens*: And in most of the Writs it is said, *Queritur*: So that if a Man release all Quarrels, (ones Deed being taken most strongly against ones self) it is as beneficial as all Actions; for by it all Actions Personal and Real are released. *Cowell's Interp.*

QUARTAN [with Physicians] an intermitting Fever or Ague, the Fit of which returns every third Day.

QUARTATION, is a way of Purifying of Gold, used by Refiners who melt three Parts of Silver with one of Gold (whence the Name) and then cast the Mixture into *Aqua fortis*, which will dissolve the Silver, and leave the Gold in a black Powder at the Bottom.

QUARTER [in Astronomy] the Period or Luration of the Moon is divided into 4 Stages or Quarters, containing each from 7 to 8 Days.



QUARTER in Heraldry, signifies a Partition made of just a fourth Part of the Field, by Two Right Lines, thus;

He beareth Argent, a Quarter Gules.

QUARTER



**QUARTER** of a Ship, is that Part of the Ship's Hull which lieth from the Steerage Room to the Transom.

**QUARTER-deck.** See Deck.

**QUARTER**, in a Military Sense, sometimes is used to signify the good Treatment given to a vanquish'd Enemy: Thus say they, *The Enemy asked Quarter; We gave no Quarter, &c.*

**QUARTER** signifies the Ground a Body of Men is Encamp'd upon; as when they say, Such a Quarter is well fortify'd; and oftentimes the Troops themselves that are there Quartered; for they say also, *We beat up the Enemies Quarters.*

**QUARTERS** of an Assembly [in Military Affairs] is the Places of Rendezvous, where the Troops are to meet and draw up for a March.

**QUARTERS** (*Winter.*) Winter Quarters sometimes is used for the Interval between two Campaigns, but more generally for the Place or Places where Troops are lodged during the Winter.

**QUARTERS** of Refreshment, are such Places as Troops which have been much fatigued and harassed, are put into, to recover their Strength or Health, during some time of the Summer Season or the Campaign.

**QUARTER-Master**, in the Land Forces, is either the Quarter-Master General of an Army, who is to see out for good Quarters for the whole; or of any Regiment of Foot, or Troop of Horse; whose Office it is to do the same for those Bodies.

**QUARTER-Master**, is an Officer Aboard a Ship (of which there are more or fewer according to her Burthen) whose Business is to rummage in the Hold on all Occasions, to overlook the Steward in his Delivery of Victuals to the Cook; and in his Pumping and Drawing out the Beer; and in general to take care there be no Waste: He is also to mind the Ship's Loading, in which he is usually employed.

**QUARTER** at a Siege, is an Encampment upon one of the most principal and important Passages round about the Place besieged, to prevent Relief and Convoys: This is either commanded by the General of the Army, and then is called, the General's Quarters, or by a Lieutenant-General.

**QUARTER Round** [in Architecture] any Moulding, the Contour of which is either a perfect Quadrant or Quarter of a Circle, or approaches near to that Figure.

**QUARTERING** [with Gunners] is when a Piece of Ordnance is so traversed, that it will shoot on the same Line, or on the same Point of the Compass as the Quarter of the Ship bears.

**QUARTERING** [in Heraldry] is the dividing a Coat into 4 or more Quarters, by parting and coupling.

*Counter* **QUARTERING** a Coat [in Heraldry] is when the Quarters are Quartered over again, or Subdivided each into 4, it is also used for distinguishing younger Brothers from elder.

**QUARTERINGS** [in Heraldry] are the several Coats born on an Escutcheon; or the several Divisions made in it, when the Arms of several Families are to be placed on the same Shield, on account of intermarriages or the like. Called also Partitions and Compartments.

**QUARTER-Sessions**, is a Court held by the Justices of Peace in every County, once in every Quarter of the Year. How far the Jurisdiction thereof extends: See *Lamb. Eirin. Lib. 4.* and

*Smith de Republ. Anglic. Lib. 2. c. 19.* The Holding these Sessions was first Ordained by the Statute of 25 Ed. III. Statut. 1. c. 18.

**QUARTER-Wheeling**, in the Military Art, is turning the Front of a Body of Men round where the Flank was. If it be done to the *Right*, the Man in the Right-angle keeps his Ground, and faces about while the Rest wheel.

**QUARTER-Wind**, at Sea, is such a Wind as comes in abaft the Main-mast Shrouds, even with the Quarter of the Ship.

**QUARTERS**, (in Architecture) are those slight upright Pieces of Timber which are placed between the Punchions and Posts, they are used to *Lath* upon.

**QUARTERIZATION**, a Part of the Punishment of a Traitor, which is the dividing his Body into 4 Parts.

**QUARTERLY** [in Heraldry] is when a Shield is divided into four equal Parts in Form of a Cross.

**QUARTERING**, is spoken of a Ship when she sails upon a Quarter Wind: 'Tis also spoken of a Piece of Ordnance, when 'tis so Traversed that it will shoot on the same Line, or on the same Point of the Compass, as the Ship's Quarter bears.

**QUARTERS** in a Clock, or Movement, are little Bells which sound the Quarters, or other Parts of an Hour. The Way of making any Clock strike them, see in *Watch-Work*.

**QUARTILE**, is an Aspect of the Planets, when they are 3 Signs, or 90 Degrees distant from each other, and is marked thus ☐

**QUASHING** [in Law] is the overthrowing and annulling a Thing.

**QUASI Contract** [in Civil Law] an Act which has not the strict Form of a Contract; but yet has the Force of it.

**QUASI Crime** [in Civil Law] is the Action of a Person, who does Damage, or Evil involuntarily.

**QUASI-Modo Sunday**, is that called *Low Sunday*, or the next after *Easter*; so called from the first Words of the *Introit*, or Hymn, for Mass on that Day; it occurs often in the Date of Old Records—*Charta Gilberti Prioris de Eynsham Priori de Sherburn dat. Postridie Festi Quasi-Modo Geniti*: And this Solemn Time is in some Old Deeds expressed only thus, *Q. M. G.* by the Initial Letters of the Words, *Quasi Modo Geniti*.

**QUAVER**, a Note in Musick so called: See the Words *Notes* and *Time*.

**QUAVERING** [in Musick] the Act of Trilling or Shaking; or the running of a Division with the Voice.

**QUE Estate**, in common Law, signifies a Plea, whereby a Man Entr'ling another to Land, &c. saith, That the same Estate he had, he hath from him.

For Example: In a *Quare Impedit*, the Plaintiff alleges, that such four Persons were seized of Lands whereunto the Advowson in question was appendant in Fee, and did present to the Church, and afterwards the Church became void, *Que estate del, &c.* that is, *Which Estate* of the four Persons he has now during the Vacation, by Vertue whereof he presented, &c.

**QUE est Mesine**, a Law Term used in an Action of Trespass, or such like, for a positive Justification of the very Act complained of by the Plaintiff, as a Wrong. For



For Example: In an Action upon the Case, the Plaintiff says, That the Lord threatned his Tenants at Will, in such sort, that he forced them to give up their Tenures. The Lord, for his Defence pleadeth, That he said unto them, That if they would not depart, he would sue them at Law: This being the same Threatning that he used, or to speak Artificially, *Quest est la Mesme*, The Defence is good.

*Queüe d'yronde*, a Term in Fortification, being what we call Swallows Tail; and signifies a Detached or Outwork, whose Sides open towards the Head, or Campaign, or draw narrower or closer towards the Gorge. Of this kind are either single or double Tenailles, and some Horn-works, whose Sides are not parallel, but are narrow at the Gorge and open towards the Head, like the Figure of a Swallow's Tail.

When these Works are cast up before the Front of a Place, they are defective in this Point, that they do not sufficiently cover the Flanks of the opposite Bastions, but then they are very well Flanked by the Place, which covers all the length of their Sides the better.

*QUEM redditum reddat*, is a Writ Judicial, that lies for him to whom a Rent-fee, or Rent-charge is granted, by Fine levied in the King's Court against the Tenant of the Land that refuseth to Attorn to him, thereby to cause to Attorn.

*QUEEN-Gold, Aurum Reginae*, is a Royal Revenue belonging to every Queen of England, during her Marriage to the King, both by Law, Custom and Prescription; and payable by divers Persons in England and Ireland (on divers Grants for the Crown) by way of Fine or Oblation, amounting to Ten Marks or upwards, viz. one full Tenth-part above the Entire Fine; as Ten Pounds on every Hundred Pound Fine, on Pardons, Contracts and Agreements: This becomes a Real Debt to the Queen-Consort by the Name of *Aurum Reginae*.

*QUENE*, as the Heralds write it, (but it should be *Queüe*) the Word in Blazon for a Tail of a Beast, thus: If a Lyon have a forken or double Tail, they say he is *Double Quened*.

*QUERELA*, an Action preferred in any Court of Justice, in which the Plaintiff was *Querent*, or Complainant, and his Brief, Complaint, or Declaration, was *Querela*.

*QUERELA coram Rege & concilio discutienda & terminanda*, is a Writ whereby one is called to Justify a Complaint of a Trespas, made to the King himself, before him and his Council.

*QUERELA frescæ fortice*, is a Writ of Fresh-force; which see.

*QUERENS non invenit per legium*, is a Return made by the Sheriff upon a Writ directed to him, with this Condition inferred, *Si A. fecerit B. securum de clamore suo prosequendo*.

*QUEST*, or *Inquest*, an Inquisition or Enquiry made upon Oath of an Impanell'd Jury.

*QUEST-Men. See Sidemen.*

*QUESTUS*, or *Questus*, in Law, is taken for that Land which does not descend to us by Hereditary Right, but is gain'd by our own Labour and Industry; this is called *Purchased Lands*.

*QUESTUS est nobis*, is the Form of a Writ of Nuisance which lies against him to whom the House, or other thing, that breeds the Nuisance, is alienated.

*QUEVE* [in Heraldry] the Tail of a Beast. Fr.

*QUIA improvide*, is taken to be a *Supersedeas* granted in the behalf of a Clerk of the Chancery, sued against the Privilege of that Court in the Common Pleas, and pursued to the *Exigent*, or in many other Cases, where a Writ is erroneously sued out.

*QUICK-Silver*: The Way and Manner how this strangely Fluid Mineral is gained; you have a good Account of by Dr. Pope in *Phil. Trans. N. 2.* Thus: It is found in the Mines of *Friuli*, a Territory belonging to the *Venetians*, about a Days Journey and a half from *Goritia* Northwards; and at a Place called *Idria*, situated in a Valley of the *Julian Alps*. They have been for 160 Years subject to the Emperour, and all the People speak *Sclavonian*. In going thither we travell'd several Hours thro' some of the finest Woods I ever saw; full of Firs, Oaks, and Beeches of an Extraordinary Thickness, Straitness and Height. The Town, like others in *Alps*, is built all of Wood but the Church; and one House, in which the Over-seer of these Mines lived. The Valley and the Mountains too, out of which the Mercury was dug, were of a pleasant Verdure, which they attributed to the Moisture of the Mercury. The best and greatest of their Mines, we went into, is dedicated to *St. Barbara*; as the other Mines are to other Saints.

At the Beginning of the Entrance, the Way was not difficult, nor the Descent great; but in many Places you cannot stand upright; this way of going down holds not long, before you descend by Perpendicular Ladders, all the way down; and the Bottom, where there are several Lanes cut out in the Mountains, is lined and propt with several great Pieces of Fir-Trees as thick as they can be set: They dig the Mineral with Pick-Axes, following the Veins: 'Tis for the most part hard as a Stone, but more weighty; of a Liver-Colour, or that of *Crocus Metallorum*. There is also some soft Earth in which you plainly see the Mercury in little Particles. Besides this, there are often found in the Mines round Stones like Flints, of several Bignesses; very like those Balls of Hair, which I have seen in *England* taken out of the Stomachs of Oxen. There are also several Marchasites, and Stones, which seem to have Specks of Gold in them; but on trial they say, they can find none. Some of these Stones are very ponderous, and well impregnated with Mercury: But others are light having little or none in them.

The manner of getting the *Mercury* is this: They take of the *Earth*, brought up in Buckets, and put it into a *Sieve*, whose bottom is made of *Wires* at so great a Distance, that you may put your Fingers between them; 'tis carried to a stream of Running Water, and washed as long as any thing will pass through the *Sieve*. That *Earth* which passeth not, is laid aside upon an Heap; that which passeth, is reserved in a *Hole*, and is taken up again, and put into a second *Sieve*; and so on to about 10 or 12 *Sieves* proportionably less. It often happens in the *First Hole*, that there is *Mercury* at the bottom; but towards the farther End, where the Intervals of the *Wire* are less, it's found in very great Proportion. The Waste Water is so much impregnated with *Mercury*, that it cureth *Itches* and other sordid *Ulcers*. The *Earth* laid aside, is Pounded, and the same Operation repeated. The fine small *Earth*, that remains after this, and out of which they can wash no more *Mercury*, is put into *Iron Retorts*, and the Fire forces the *Mercury*



into the *Receivers*: The Officer unluted several of them; and I observed in all that he first poured out *Perfect Mercury*, and after that came a *Black Dust*, which being Wetted with Water, discovered it self to be *Mercury*, as the other was. They take the *Caput Mortuum* and Pound it, and Renew the Operation. There are 16 *Furnaces* for this Use, each of them carrying 24 *Retorts*; in all 384 *Retorts*.

All the *Mercury* got without the use of *Fire*, whether by *Washing*, or found in the *Mines*, (for in the Digging some, the Particles get together, so that in some places you might take up two or three *Spoonfuls* of pure *Mercury*) is called by them *Virgin Mercury*, and esteemed above the rest. The Officer told me, that making an *Amalgama* of Gold and *Virgin Mercury*, and putting it to the *Fire*, that *Mercury* would carry away all the *Gold* with it, which *Common Mercury* would not do.

The *Engines* for drawing the Water, are all moved by Water, brought thither in no Chargeable *Aqueduct* from a Mountain 3 Miles distant. The Water Pump from the bottom of the *Mine*, by 52 *Pumps*, 26 on a side, is contrived to move other *Wheels*, for several other Purposes.

| Anno 1661.               | Anno 1662. | Anno 1663. |
|--------------------------|------------|------------|
| Ordinary Mercury. 198481 | 225066     | 244119     |
| Virgin Mercury. 6193     | 9612       | 11862      |
| in all 204675            | 234678     | 255981     |

The Town of *Idria* in the County of *Goritia* and Province of *Friuli*, is seated low, and encompassed with Hills on all sides. A *River* of the same Name runs by it, and proves sufficient upon plentiful Rains to convey down the *Fir-Trees* and other Wood required in the Service of the *Mines*: And to this End there is an handsome Work of *Piles* made sloping athwart the *River* (after the same manner as I observed in *Newsol* in *Upper Hungary*, cross the *River Gran*) to stop the Trees.

The Entrance into these *Mines* is not high, or upon an Hill, but in that Town it self. The deepest part of the *Mine* from the Entrance, is between 120 and 130 *Fathoms*.

The *Virgin Quick-Silver*, which they call *Jungfraw*, is that which discovers it self without the help of *Fire*. Sometimes it is plainly seen in the *Ore*, or falls down in *Drops*, and sometimes *Streams* out in good quantity; as about Seven Years ago it ran out of the Earth at first in a *Stream* as small as a Thread, and afterwards as big as a Packthread, but ceased in 3 or 4 Days. That also is accounted *Virgin Quick-Silver*, which is separated only by *Water*.

Plain *Quick-Silver* they obtain by *Fire* out of the *Ore*, and out of the *Cinnabar* of *Mercury*, which they dig out of this *Mine*. The *Ore* of this *Mine* is of a *Dark Colour* mixed with *Red*.

The *Quick-Silver Ore* of this *Mine* ordinarily contains half, and sometimes  $\frac{2}{3}$  of *Quick-Silver*.

I went into the *Mine* by the Pit of *St. Agatha*, and came up again by that of *St. Barbara*, descending and ascending by Ladders. I ascended at one of 639 Staves, or 89 *Fathoms*. It has been wrought

The *Labourers* (being 280 always employed) work for a *Folio a Day*, which is not above 6 or 7 pence, and Endure not long: For although none stay under-ground above 6 Hours; all of them in time (some latter, some sooner) become *Paralytick*, and die *Hestick*. We saw a Man who had not been in the *Mines* for above half a Year before, so full of *Mercury*, that putting a piece of *Braß* in his Mouth, or rubbing it in his *Fingers*, it immediately became as *White*, as if he had rubbed *Mercury* upon it. Those also that work upon the Back-side of *Looking-Glasses*, are very Subject to the *Palsy*.

They convey their Wood thus. About 4 Miles from the *Mines* on the sides of Two Mountains, they cut down the Trees, and draw them into the Interjacent Valley. Higher up in the same Valley they make a *Lock* or *Dam*; when the Water is ready to run over it, they open the *Flood-Gates*, and the Water carries all the Trees impetuously to *Idria*, where the Bridge is built very strong, and at very Oblique Angles to the Stream, on purpose to stop them, and throw them on shore near the *Mines*.

Those *Mines* heretofore Cost the Emperor 70000 or 80000 *Florins* yearly; but now they Cost him not above 28000. They produced

200 Years, about the same space of time with *Newsol Mine*; but comes much short in time of the *Silver Mine* at *Schemnitz*; and much shorter yet of the notable *Lead Mines* in *Upper Carinthia*.

In a *Laboratory*, where the *Quick-Silver* is separated by *Fire*, I saw an Heap of 16000 *Retorts* of *Iron*; every one of which costs a *Crown* at the best Hand from the *Iron Furnaces* in *Carinthia*. There are 800 *Retorts*, and as many *Recipients*, employed together, in drawing over the *Quick-Silver* in 16 *Furnaces*; 56 in each *Furnace*, 25 of a side; 12 above, and 23 below of each side.

June 12. 1669, when I was there, they carried out 40 *Saumes* of *Quick-Silver* into Foreign Parts, each *Saume* containing 315 pound Weight, to the value of 4000 *Ducats* of *Gold*. Some of it is sent as far as *Cremnitz* in *Hungary*, for the Use of the *Gold Mines*: And very much is carried away Southward; for they are not far from the *Sontius*, or *Lysonzo*, a considerable River, which runs into the *Gulf* of *Trieſte* in the *Adriatick Sea*.

In the Castle I saw 3000 *Saumes* of *Quick-Silver* together in Barrels, the *Quick-Silver* being first made up in double Leather: And in another House as much *Ore* as can be distilled in 2 Years, except they have great Plenty of *Rain* to bring down the *Wood*.

The Country is well stored with stately *Firs*, *Larches*, *Pines*, *Pinasters*, *Picea's*, and that nobly crisped and well grain'd kind of *Acer*, whereof *Viols* and *Violins* are made: Whereof there is also Plenty in the Country of *Saltzburg* and *Carniola*.



Travelling sometimes in the Night, we had continually about us a great number of large *Glow-worms*, which put into Papers, give a dim Light like Candles in Lanthorns; and the Air also was full of *Flaming Flies*, affording some delight unto us.

The way to this Place from *Croatia* I found difficult; and coming from it to *Aidoschini* and *Croatia*, I passed over *Swartzenburg*, or the *Black Mountain*, from whence I descended 10 Miles in a Rocky Country, and far more Stony than the *Craze*, or *Campus lapidosus*, in *Provence*.

In the Valley of *Lancy*, which runs between the Mountains of *Turin*, grows a Plant like the *Doronicum*, (so also called by the Inhabitants and Botanists,) near the Roots whereof you may find *Pure Quick-Silver*, running in small Grains like *Pearls*; the Juice of which Plant being expressed, and exposed to the Air of a clear Night, there will be found as much *Mercury*, as there is lost of the Juice.

**QUID juris clamat**, is a Writ Judicial, issuing out of the Record of the Fine, which remaineth with the *Custos brevium* of the Common-Pleas, before it be engrossed; and it lies for the Grantee of a Reversion or Remainder, when the particular Tenant will not Attorn.

**QUID pro quo**, in Law is used for the Reciprocal Performance of both Parties to a Contract, and thereupon the giving of one thing of a Value for another thing of like Value, as 10*l.* for a Horse, &c.

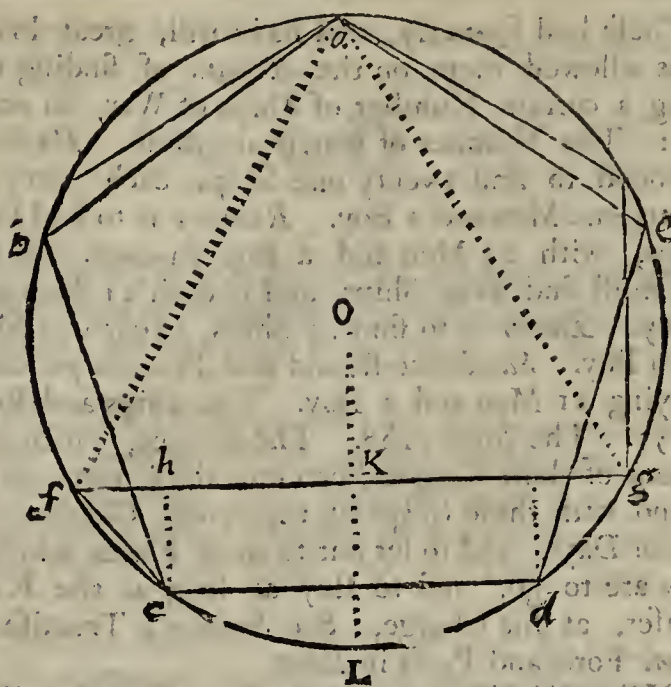
**QUIETUS**, is a Word used by the Clerk of the Pipe, and Auditors in the Exchequer, in their Acquittances or Discharges given to Accomptants, usually concluding with an *abinde recessit quietus*, which is called a *Quietus est*, and mentioned in the Act of General Pardon, 12 Car. 2. 11. and 14 Car. 2. Cap. 21. A *Quietus est*, granted to the Sheriff, shall discharge him of all Accounts due to the King.

**QUIETUS**, was formerly a Writ of Discharge granted to those Barons and Knights, who personally attend the King in his Wars, or any Foreign Expedition; by which they were exempted from the Claim of *Scutage*, or a Tax on every Knights Fee.

**QUINCUNX**, that Position, or Aspect, that the Planets are said to be in, when distant from each other 150 Degrees, or 5 Signs, and is mark'd thus, *Vc.* or *Q.*

**QUINDECAGON**, is a plain Figure of 15 Sides and Angles, which if they are all equal to one another, is called a Regular Quindecagon; which how to describe in a Circle, *Euclid* shews Prop. 16. e. 4.

The Side of a Regular Quindecagon, so described, is equal in Power to the half Difference between the Side of the Equilateral Triangle, and the Side of the Pentagon, and also to the Difference of the Perpendiculars let fall on both Sides, taken together.



Make the Pentagon *a b c d e*, and parallel to any one Side of it, set the Base of the Equilateral Triangle *f g a*. Then (by 16. e. 4 *Eucl.*) will *f o* be the Side of the Quindecagon, *f h* =  $\frac{1}{2}$  the Difference between the Side of the Triangle and Pentagon; and *h c* = to the Difference of the Perpendiculars let fall from the Centre *o*, to both the Sides of the Figures.

But  $\square f c = \square f h + \square h c$ , by 47. c. *Euclid*. Wherefore the Proposition is true, &c.

**QUINQUAGESIMA**; See *Quadragesima*.

**QUINQUANNION** [in Ancient Customs a

**QUINQUENNIOM**; Respite of five Years, granted by the King's Letters to Insolvent Debtors; to have time for the Payment of their Debts.

**QUINQUEANGLED**, in Geometry, is a Figure consisting of five Angles.

**QUINSIE**, or rather *Squinancy*, a Disease so called. See *Angina*.

**QUINTAL**, or *Quintan*, was an old Sportive Exercise, practiced usually at Weddings, and was either so dangerous or ludicrous as to be forbid often by Ecclesiastical Authority; The manner of it was thus: A Post was erected perpendicularly in the Ground, on the Top of which was a slender Beam turning round on a Spindle: At one of whose Ends was a Sloap or flat Board; and at the other a Bag of Sand or Dirt. And the Sport was with a long Staff or wooden Lance to ride a Tilt at the Board, and to be either so skillful or lucky to escape the Blow which the Sand Bag would be likely to give the Runner at this Quintan, by the turning round of the Beam. This seems to have been the same with that Sport called *Arietum Levatio*, which is frequently prohibited in our Old Synods and Episcopal Constitutions. *Kenet Par. Antiquities*.

**QUINTAL**, also was formerly used for a Weight of Lead, Iron and common Metals, of usually an Hundred Pounds; at Six-score to the Hundred.

**QUINQUE-Portus**, the *Cinque* or *Five Ports* of the Kingdom of *England*, were so called formerly by way of Eminence: They are *Hastings*, *Dover*, *Romney*, *Hitbe*, and *Sandwich*. There belongs to them also, two Ancient Towns, which are *Winchester*, and *Rye*; and several other Places which are called their *Members*; as *Seaford*, *Faversham*, *Folkstone*, &c.



These had formerly, and have still, great Privileges allowed them on the account of finding the King a certain Number of Ships of War, on occasion: The Number of which are these. *Hastings* is bound to find twenty one Ships, each carrying twenty one Men and a Boy. *Romney* is to find Five Ships, with 24 Men and a Boy in each. *Hithe* also must find Five Ships, and in each 21 Men and a Boy. *Dover* is to find 21 Ships, in each 21 Men and a Boy. *Sandwich* should find Five Ships, each carrying 21 Men and a Boy. The Ships and Boys are 57. The Men 1188. The Service, which the Barons of these Cinque-Ports owe the Crown, is to attend with these Ships at their own Charges for fifteen Days, and to set out to those Places whither they are to go, and to stay as long as the King pleases, at his Charge. See *Somner's Treatise of Rom. Forts and Ports in Kent*.

QUINZIEME } [in old *Law Books*] a Tax  
QUINSIEME } levied at Rate of a fifteenth part of all Lands; it being only of the Goods.

QUINTESSANCE, is a Medicine made of the Energetical and Active Particles of its Ingredients, separated from all Fæces or Dregs.

QUINTESSANCE [in *Alchymy*] is a mysterious Term used by the Alchymist to signify the fifth, or last, and highest Essence or Power of a natural Body.

QUINT *Exalt*, in Law, is the last Call of a Defendant, who is used to the Outlawry, where, if he appear not, he is by the Judgment of the Coroners returned *Outlawed*; if a Woman, *Waved*. See *Exigent*.

QUINTILE, an Aspect of the Planets when they are 72 Degrees distant from one another, and noted thus, C or O.

QUINTUPLE, Five-fold or five times as much as another thing.

QUIRK, is a Term in Architecture for a Piece of Ground whether Square or Oblong, taken out of a Corner, or any Place else of a Ground-plat, to make a Court or Yard, &c.

QUITE *Claim*, is a Release or Acquitting of a Man from any Action he hath, or might, or may have against him.

QUIT-Rent, is a certain small Rent, payable yearly, by the Tenants of most Mannors; upon the payment whereof they are to be quit, till it becomes due again.

QUO *Jure*, is a Writ that lies for him that has Land, wherein another challengeth *Common of Pasture*, Time out of Mind: And it is to compel him to shew by what Title he Challenges it.

QUO *Minus*, is a Writ that lies for him that hath a Grant of House-bote and Hey-bote in another Man's Woods, against the Grantor, making such Waste as the Grantee cannot enjoy his Grant. This Writ lies also for the King's Farmer in the Exchequer, against him to whom he selleth any thing by way of Bargain touching his Farm, or against whom he hath any Cause of Personal Action: For he supposeth by the Vendees detaining any Due from him, he is made *less able* to pay the King's Rent; and under this pretence, any one who pays the King a Fee-Farm Rent, may have this Writ against any other Person, for any Debt or Damage, and bring the Cause to Trial in the *Exchequer*.

QUO *Warranto*, is a Writ that lies against him that Usurps any Franchise or Liberty against the King, as to have Waife, Stray, Fair, Market, Court-Baron, Leet, or such like, without good Title: Or else against him that intrudeth himself as Heir into Land.

QUOD *Clerici noneligantur in Officio Ballivi*, &c. is a Writ that lies for a Clerk, which by reason of some Land he hath, is made, or in doubt to be made Bayliff, Beadle, Reeve, or some such like Officer.

QUOD *Clerici beneficiati de Cancel*, is a Writ to exempt a Clerk of the Chancery from Contribution towards the Proctors of the Clergy in Parliament.

QUOD *ei deforcit*, is a Writ that lies for the Tenant in Tail, Tenant in Dower, or Tenant for Term of Life, having lost by Default against him that Recoverd, or against his Heir.

QUOD *permittat*, is a Writ that lies for the Heir of him that is disseised of his Common of Pasture, against the Heir of the Disseisor being Dead.

QUOD *Persona nec Prebendarii*, &c. is a Writ that lies for Spiritual Persons that are distrained in their Spiritual Possessions, for the Payment of a Fifteenth with the rest of the Parish.

QUODLIBET any thing what you please.

QUODLIBETICAL Questions [in the Schools] a Term used for a Thesis or Problem, proposed to be debated by the Collegians out of Curiosity, and for Entertainment, rather than for the settling of any useful Point.

QUOILE, or Coile, at Sea; is spoken of Cables or Ropes, when they are placed in a round or Oval Ring one *Fake* (or Turn) upon another: that so they may the more easily be stowed out of the way, and also run out free and smooth, without *Knecks* or *Kenks* as they call them; i. e. without Twistings or Doublings: Then the Cable is said to be *Quoiled* up.

QUOIN, a Sea Word, the same with *Coin*; which see.

QUOINS are the Stones and Bricks placed in the Corner of any Building; and if any stick without the Brick-work (their Edges being Cypher'd off) they are called *Raftick Quoins*.

QUORUM, a Word often used in our Statutes, as also in Commissions, both of Justices of the Peace, and others. As for Example, where a Commission is directed to seven Persons, or to any three of them, *whereof* A. B. and C. D. to be two, there A B C D. are said to be of the *Quorum*, because the rest cannot proceed without them: So a *Justice of the Peace*, and *Quorum*, is one, without whom the rest of the Justices, in some Cases cannot proceed.

QUOTIDIAN *Ague*, is that, whose Fits return every Day.

QUOTIENT, is that Number in Division which arises by dividing the Dividend by the Divisor: And is called Quotient, because it answers to the Question *Quoties?* Or how often one Number is contained by another?

Thus:

If 360 be to be divided by 24, the Quotient will be 15, and the Numbers will stand thus:

24) 360 (15.

Where 15 is the Quotient.

QUOYLE, is a Sea Word: They say a Cable is *Quoyled*, when 'tis laid round in a Ring on the Deck, or Floor of a Ship; in the middle of which Ring, or *Quoyle*, is a good Place to lay Shot in; which is more safe there than in Lockers along the Side; for there the Enemies Shot may fall into it, and beat it about among the Men.



## R A D

**RABANET.** See *Rabinet*.

**RABBETTING** in a Ship, is the letting in of her Planks to the *Keel* which in the *Rake* and *Run* of the Ship, is hollowed away, that the Planks may join the better and closer, and this hollowing away, is called the Rabbet of the Keel.

**RABDOIDES**, the same that *Sutura sagittalis*.

**RABINET**, a sort of Ordinance, whose Diameter at the Bore is  $1\frac{1}{2}$  Inches, Weight 500 Pound, Length 5 Foot, Load  $\frac{3}{4}$  of a Pound, Shot something more than an Inch and a quarter Diameter, and  $\frac{1}{2}$  a Pound Weight.

**RACCOURCY** [in *Heraldry*] that which is cut off or shortned, the same as *Coupee*, as a Cross or other Ordinary that does not extend to the edges of the Escutcheon, as they do when named without Distinction.

**RACHAT**, *Rachetum*, from the French *Racheter*, to redeem, was formerly used for the same as *Theft-bote*, viz. the Compensation or Redemption of a Thief, *Skene de verb. signif.*

**RACHITÆ**, and *Rachiet*, or Muscles belonging to the Back; so called by some Foreign Anatomists, and seem to be the same with what we call *Semispinari*.

**RACHITIS**, See *Rhachitis*.

**RADECHENISTORS** in Dooms-day book, is used for *Liberi-Homines*; and *Spelman* thinks it to be what *Bracha* calls *Rade-knights*.

**RADIAL-Curves** are Curves of the Spiral-kind, whose Ordinates, if they may be so called, do all terminate in the Centre of the including Circle, and appear like so many *Radii* or Semi-diameters of that including Circle. See *Spiral*.

**RADIALES Externus & Internus**, are Muscles of the Wrist, the one serves to bend it, and the other to extend it. *Blanchard*.

**RADIATED** [in *Botany*] a Term apply'd to round flat Flowers, which consist of a Dish, and a single Row of longish pointed Leaves, ranged all around it, after the manner of Rays, or Spokes.

**RADIANT Point** [in *Opticks*] is any Point

**RADIATING Point** of a Visible Object, from whence Rays proceed, every Radiating Point diffuses innumerable Rays all around, but those Radiants only are visible, from which right Lines may be drawn from the pupil, because the Rays are all right Lines; all Rays which proceed from the same Radiant continually diverge; and the Chrystalline collects or reunites them again. Every Ray carries with it the Species or Image of the Radiant.

**RADIATION**, signifies the casting forth of Beams, or Rays of Light; and in Opticks it is considered as threefold, viz. *Direct*, *Reflected*, and *Refracted*. See *Ray*.

Place of **RADIATION** is that space in a transient Body or Medium, through which a visible Body radiates.

**RADIATION** [in *Medicine*] is a Term used by some Authors, to signify the manner of Motion of the animal Spirits; they supposing that they are diffused from the Brain towards all the Parts of the Body, through the small Canal of the Nerves, as Light is from a Lucid Body.

## R A D

**RADICAL** [in *Physicks*, &c.] something which serves as a Basis or Foundation, or which is the source or principal whence any thing arises as from a Root.

**RADICALS** [in *Grammar*] are primitive Words or Roots, in opposition to compound or derivative.

**RADICAL Sign** [in *Algebra*] the Sign or Character  $\sqrt{\quad}$  is the Character of Radicality, and expresses the Square Root,  $\sqrt[3]{\quad}$  the Cube Root, &c.

**RADICAL Moisture**, is a Term used by some, for the Fundamental Juice of the Body, which they will have to nourish and preserve the natural Heat, as the Oil in a Lamp preserves and feeds the Flame. *Blanchard*.

**RADICATION** [in *Botany*] is the Action whereby the Plants take Root, or shoot out Roots.

**RADICLE**, a Word used by Botanists, to denote that Part of the Seed of a Plant, which upon its Vegetation becomes its Root: This in Corn is that which Malsters upon its shooting forth, call the *Come*. 'Tis not easily to be discerned in many Seeds, by the naked Eye: but in that of Fenugreek, 'tis as big as one of the Lobes: And in the Garden-bean it appears visible on the Separation of the Coats, it is of a White Colour, more Glossy than the Main Body, and stands at the greater End without the Lobes: Therefore this End in setting Seeds, should always be placed lowermost,

**RADIUS**, in Geometry, is the Semi-diameter or half the Diameter of a Circle: See under the Word *Circle*.

**RADIUS**, is the left Bone of the Cubit, called *Focileminis*; it is more oblique than the great Bone, called *Ulna*, and is distant a little from it in the middle, where there occurs a small Ligament above the *Ulna* which receives the *Radius*, and below the *Radius* receives it. The upper Part of the *Radius* is jointed with the outward Process of the Arm by *Diarthrosis* (which see); the lower by way of Appendix with the Wrist Bone, at the Middle Finger. Its upper end is small, and the lower thick. The greater Bone of the Leg also is called *Radius*. *Blanchard*.

**RADIUS** [in *Mechanicks*] the Spokes or Fellows of a Wheel, so called because they issue like Rays from the Centre of it.

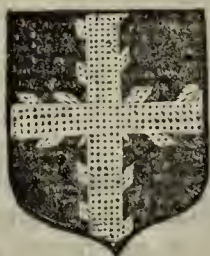
**RADIX** [in *Anatomy*] the Sole of the Foot.

**RADMAN** is a word often used in Dooms-day Book and seems to be the same with *Rade-knight* or *Rad-knight*. Others think it comes from *Read*, Counsel, and then *Read-man*, is a Counsellor.

**RAFTERS**, in any Building, are those Pieces of Timber, which stand by pairs upon the *Reason*, meet in an Angle at the Top, and help to compose the Roof of a Building: They should not stand farther than 12 Inches from one another.

**RAGEMAN**, is a *Statute* so called, of Justices assigned by K. *Edw. 1.* and his Counsel, to go a Circuit through all *England*, and to hear and determine all Complaints of Injuries done within 5 Years next before *Michaelmas*, in the fourth Year of his Reign. *Cowel*.





RAGGULED, the Heralds Term for any Ordinary, *Ex. gr.* a Cross whose out Lines are of this Form.

He beareth *Sable*, a Cross *Ragguled Or*, by the Name of *Stoway*.

This differs from Indented, because that is regular, and this is not so, but rather ragged.

RAIL [in *Architecture*] a Piece of Timber, &c. lying Horizontally between the Pannels of Wainscot; also that lies over and under Ballasters in Balconies, Stair Cases, &c. and also to those Pieces of Timber which lie Horizontally from Post to Post, in Fences with Pales or without.

RAINBOW or *Iris*: the very Learned and Ingenious Mathematician, Mr. *Edward Halley*, in a Discourse *de Iride* in *Phil. Transact.* No. 267, gives the best Account that we have ever had, of the Cause of the various Colours of the Rainbow, and the Solution of their several Phænomena. He tells us there, that the Ingenious *Des Cartes* was the first, that by applying Mathematicks towards the Investigation of this surprizing Appearance, ever gave a Theory of the *Iris*: And he found the Laws of Refraction, which the Lucid Rays suffer in passing thro' any Diaphanous Bodies: And clearly demonstrated the *Primary Iris to be only the Sun's Image, reflected from the Concave Surfaces of an Innumerable Quantity of small spherical Drops of falling Rain: With this necessary Circumstance, that those Rays, which fell on the Objects, Parallel to each other, should not after one Reflection, and two Refractions, viz. At going into the Drop, and coming out again be dispersed, or made to Diverge, but come back again also to the Eye, parallel to each other.*

He shewed also, that the Colours, in the Rays of Light were produced by those Refractions as they are by passing through a Triangular Glass Prism. The *Secondary Iris*, he supposes produced by those Rays of the Sun, which fall more Obliquely, but after the same Manner as before, only in these there are two Reflections, before the Sun's Rays refracted a second time, and tending towards the Eye, in a parallel Position, can get out from the Aqueous Globules. The Magnitude of the *Iris*, he makes to depend on the Degrees of Refraction; which is different, in different Liquors, or Transparent Solids: But supposing the Ratio of the Sines of Incidence, to those of the refracted Angles, to be in Water as :: 250. to 187, he determined thence the Semi-diameter of the *Iris*, near enough to Observation, *viz.* The Primary one to be 41 Degrees 30 Minutes, and the secondary one to be 51 Degrees 54 Minutes. See the 8 *Chap.* of his *Meteors*.

Mr. *Halley* observes, that *Des Cartes* using only a Tentative and Indirect Method, in determining his Angles seems not to understand the Easiness of solving his own Problem.

Wherefore because hardly any one hath written well on this Subject since *Des Cartes*, he shews you there how to determine the Angle by which the *Iris* is distant from the opposite Point of the Sun, and the Ratio of the Refraction being given Geometrically, or *vice versa* the *Iris* being given, to determine the Refractive Power of the Liquor.

And first he saith, is is plain from *Des Cartes's* Demonstrations, that the Primary *Iris* is made by

the Sun's Rays, where the Excess of the two Refracted Angles above the one of Incidence, is the *greatest* possible.

And the Secondary *Iris* is formed by those Rays, where the Excess of three Refracted Angles above one of Incidence, is also the *greatest* possible.

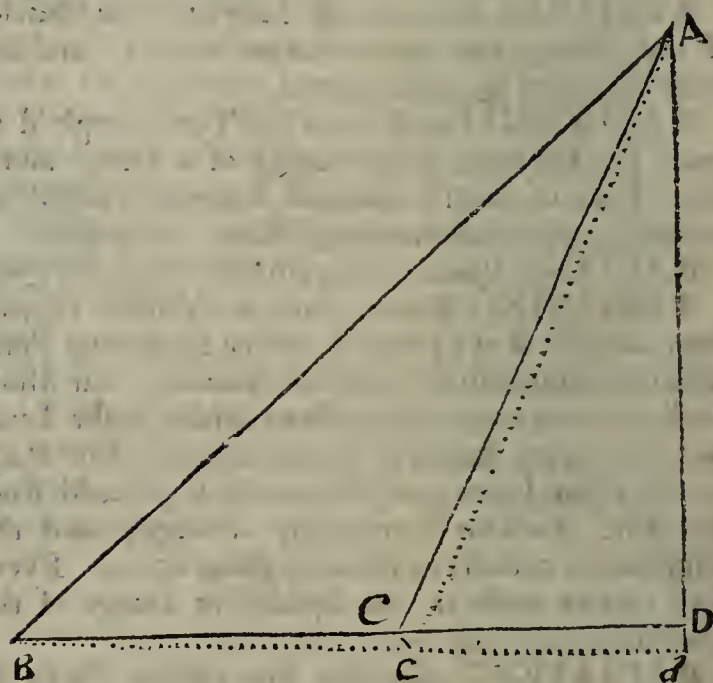
And thus you may go on to 3, 4, 5, or 6 *Iris's*, which will all be formed where the Rays Emerge out of the Watery Cloud after 3, 4, 5, or 6 Reflections; but none but the Second will be ordinarily visible in the Heavens, because the Rays of the Sun grow at last very much attenuated and weakened.

Now if you double this greatest possible Excess of the refracted Angles above that of Incidence, (if the Number of Reflections be odd) it will give the Distance of the *Iris* from the Point opposite to the Sun.

But if the Number of Reflections be even, then the double of the greatest refracted Angle, will be the Distance of the *Iris* from the Sun himself.

Now to gain these Greatest Excesses, having the Refraction of any Liquor, or the Ratio of the Sine of the Angle of Incidence to the Sine of the refracted Angle, you must observe, that the Excess of two refracted Angles, above one of Incidence, will be Greatest where the Momentaneous Augment or Fluxion of the Angle of Incidence, is precisely double to the Momentaneous Augment of the refracted Angle. And if there be three refracted Angles, the Greatest Excess will be where the Momentaneous Augment of the Angle of Incidence is Triple of the Moment of the refracted Angle, and so on, which is sufficiently evident.

But in order to find the Angles themselves, Mr. *Halley* premises the following Lemma.



Let there be a Triangle *A B C*, whose Vertex is at *A*; its Legs *B A* and *C A*, and the Base *B C*; on which produced, let fall the Perpendicular *A D*. Then let the Vertical Angle *B A C* be supposed to be increased by a Quantity infinitely small, as suppose by the Moment *C A c*: Then drawing the Lines *B C d*, and *c D*, they will be only imaginarily different from *B C D* and *C D*.



This done, I say, That if the Legs of the Plane Triangle  $BAC$ , (or any other) continuing the same, the Vertical Angle be imagined to be encreased by any infinitely small Moment or Fluxion, then will the Moments of the Angles at the Base, be reciprocally as the Segments of the Base: That is,  $CBc$ , is to the Moment of the Angle  $ACB$ , or  $ACD$  :: as  $CD$  is to  $BD$ .

For since the external Angle  $ACD =$  to  $ABC +$  Angle  $BAC$ , its Moment must also be equal to the Sum of their Moments, or to  $CBc + CAc$ : but now because the Triangle  $ACD$  is right-angled at  $D$ ,  $AC$  may be the Diameter of a Circle, whose Periphery will pass through  $A, D, C$ , and  $c$ , and consequently the Angles  $CAc$ ,  $CDc$  being in the same Segment are equal. So that the Sum of the two Fluxionary Angles  $CBc$ , and  $cDc$  (*i. e.* the external Angle  $Dcd$ ) will be the Moment of the Angle  $ACD$ , or  $ACB$ . But those  $CBc$ , and  $Dcd$ , being infinitely small, will be to each other, as the Sides opposite to them, or as  $cD$  or  $CD$  is to  $BD$ : That is, reciprocally as the Segments of the Base. *Q. E. D.*

If  $B$  and  $C$  had been both Acute, the way of Proof is the same, all Things considered.

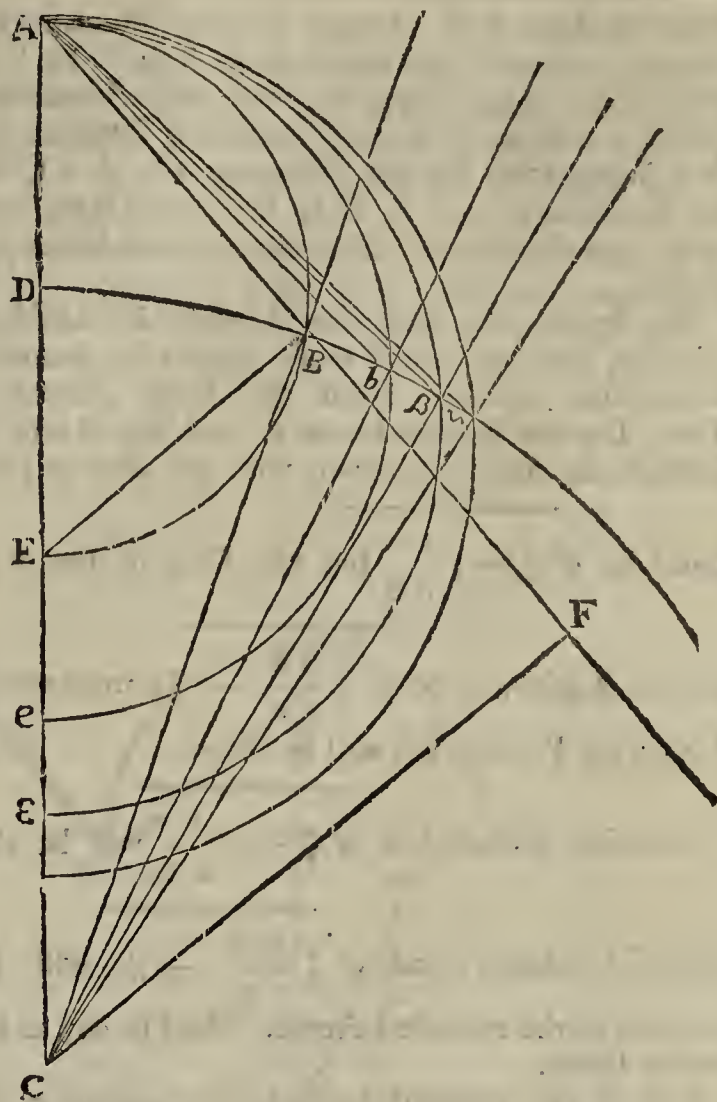
#### COROLLARY.

Hence it follows, That the Moments of the Angles at the Base, are to one another directly as the Tangents of these Angles.

By the help of this Lemma he shews how to obtain the Diameter of any Iris, either Geometrically, or by Calculation.

Let there be any Right Line as  $AC$ , and let it be so divided in  $D$ , that  $CA$  may be to  $CD$  :: according to the Ratio of Refraction; that is, in Water :: as 250 is to 187, or more nicely :: 529 is to 396. Then let it be divided again in  $E$ , so that  $CE$  shall be to  $AE$  :: as Unity is to the Number of Reflections which the Solar Rays must undergo in producing the Iris proposed: This done; on the Diameter  $AE$  let the Simicircle  $ABE$  be described; and on the Centre with the Radius  $CD$ , draw the Ark  $BD$ , cutting the Semi-circle  $ABE$  in the Point  $B$ . Then drawing the Right Lines  $CB$ ,  $AB$ , let the Perpendicular  $CF$ , be let fall on  $AB$  produced to  $F$ ; and to that Perpendicular draw the Parallel  $EB$ .

I say the Angle  $CBF$  is the Angle of Incidence;  $CAB$  is the refracted Angle, both required for producing the proposed Iris.



#### DEMONSTRATION.

Since the Triangles  $ACF$ ,  $AEB$  are Similar,  $AF$  will be to  $BF$  :: as  $AC$  to  $EC$  :: that is, as the Number of Reflections augmented by Unity, is to Unity; by the Construction.

Wherefore the Moment of the Angle  $CBF$ , is to the Moment of the Angle  $CAB$  in the same Ratio, by the Lemma.

But the Sign of the Angle  $CBF$ , is to the Sine of the Angle  $CAB$  :: in the Ratio of their Sides  $CA$ ,  $CB$ : That is, in the Ratio of the Refraction given.

By the Construction also, the Angle of Incidence  $CBF$ , hath its corresponding Refracted Angle  $CAB$ : Wherefore since their Moments are in the Ratio proposed, those are the Angles sought or required. *Q. E. D.*

Now therefore multiplying the Refracted Angle by the Number of Reflections augmented by Unity, and from the Product Subtracting the Angle of Incidence, you will have half the distance of the Iris from the Sun, if the Number of Reflections were even; but if they were odd, from the opposite Point of the Sun as was said before.

And from hence, by a very easy, short, and elegant Construction, he shews how to exhibit to the Eye, the Incidences of all manner of Iris's, as they will appear in any Liquor whose Refraction is given. For, if the Line  $AC$  in the last Figure, bisected in  $E$ , have a Third part cut off from it in  $e$ , a Fourth part in  $E$ , a Fifth part in  $n$ , &c. And then there be Semicircles described on the Diameters  $AE$ ,  $Ae$ ,  $AE$ ,  $An$ , &c. all which shall be cut by the Circular Ark  $DBb$ , and  $v$ , described on the Centre  $C$  with the Radius  $CD$ , (which Radius  $CD$  is to  $AC$  in the Ratio of the given Refraction) in the Points  $Bb$ ,  $Bv$ , &c. I say, the Lines  $AB$ ,  $Ab$ ,  $AB$ ,  $Av$ , shall make with



with the Line A C, Angles equal to the refracted Angles, and with the Radii C B, C b, C B, C v, respectively Angles equal to those of Incidence required; that is, A B C (or rather its Complement to a Semicircle) for the *Primary Iris* A b C for the Secondary one, A B C for the Third, and A v C for the Fourth, &c. and so on as far as you please.

He shews also, that the Reader, if skill'd in Algebra, may easily find these Angles by Accurate Calculation, derived from the same Fountain: Thus, Let the Radius be = 1. and the Ratio of Refraction, as  $r$  to  $s$ ; then will the Sine of Inci-

dence be  $\sqrt{\frac{4}{3} - \frac{1}{2} \frac{r}{s} \frac{r}{s}}$  but the Sine of the Re-

fracted Angle will be  $\sqrt{\frac{4}{3} \frac{s}{r} \frac{s}{r} - \frac{1}{2}}$ ; from which Angles the Primary Iris will be found.

For the Second Iris  $\sqrt{\frac{2}{3} - \frac{1}{2} \frac{r}{s} \frac{r}{s}}$  will be the

Sine of Incidence; and  $\sqrt{\frac{2}{3} \frac{s}{r} \frac{s}{r} - \frac{1}{2}}$  will be the Sine of the refracted Angle. And so on, as he further shews.

And if you proceed to Calculate according to D. Cartes his Proportion, the Primary Iris will be Distant *ab Opposito Solis*  $41^{\circ} 30'$ , the Secondary one  $51^{\circ} 55'$ . But the Third and Fourth will be distant  $40^{\circ} 20'$ , and  $45^{\circ} 33'$  from the Sun himself; but probably no one can ever see either of these, for the reasons above given.

As to the Colours with which this wonderful Bow is adorned, he observes, That our most Sagacious Sir *Is. Newton* was the first who shewed by most plain Experiments, that the Rays of Light do not come uniform and simple out of the Luminous Body; but that the pure white Light which we see, is compounded of the Corpuscles of all manner of Colours, blended one with another, by the most rapid Motion; and, That the Colours of all Bodies arise from their different Disposition to refract or reflect some peculiar Species of Light. This is principally proved from *Refractions*, by which those *distinct Species* are separated one from another; for Blue or Purple Light is, for Instance, more refracted in passing through a Diaphanous Body, than Yellow or Red. See the Words *Light* and *Colours*, where I have given you a large Account of Sir *Is. Newton's* Experiments, as mentioned in his Letter in the *Phil. Trans.* N. 80, &c.

It being therefore certain that all kind or degrees of blue Light, are a little more refracted than any reddish Light whatsoever, 'Tis plain, saith Mr. *Halley*, that from this difference the breadth of the Iris must arise; but which, is hardly to be determined by Observation, by reason of the uncertain Limits of the Colours in the Clouds. But the greater the Ratio of Inequality between C A and C D, or the greater the Refraction is, by so much the greater will the Distance be of any *Iris* from the Sun; so that those which are more remote from the Sun, are always more adorned with a Purple Colour, but the more near ones with a Red one, as is apparent in the *Primary Iris*, which vanishes or disappears in *Opposito Solis*, if the Sine of Incidence to that of the refracted Angle be as C A to

C E :: or as 2 to 1. And if the Ratio be greater than this, the Primary Iris will not be at all visible, or no Primary Iris at all can be seen.

It is to be observed also, That the *Secondary Iris* will go off in a Point, in *Opposito Solis*, whenever the Ratio of Refraction is as 1. to  $\sqrt[un]{\frac{1}{2}} + \sqrt{\frac{4}{27}}$  or as 1 to 0. 847487. And from thence will run back towards the Sun himself, and there disappear, if the aforesaid Ratio be as 3 to 1, or as C A to C e.

But in the Intermediate Proportions, (which are found in all known Fluids except Air) the greater the Ratio of Refraction, the further is the Iris distant *ab Opposito Solis*, or rather from the Sun himself, the Ark being numbered beyond the Semicircle; and therefore the Colours will appear to be found in an Order diverse from that in the *Primary Iris*, unless you thus reckon the distance of the Secondary one from the Sun himself, which must also be taken notice of in the other *Iris*.

The Third *Iris* in *Opposito Solis* is quite confused; the Ratio of the Refraction being as 1 to 91855, and from thence it runs back in the Ratio of 1 to 68250; from whence again, the order of the Colours being restored, in the Ratio of 4 to 1, or of C A to C e, it ends in *Opposito Solis*.

But the Fourth *Iris* beginning from the Sun in the Ratio of Equality, passes off in the Points opposite to him in the Ratio of 1 to 94895, and thence returns to the Sun again, if the Ratio be as 1 to 4; and from thence is again dispersed or scattered towards the Parts opposite to the Sun, in the Ratio of 1 to 56337, within which Bounds are the Refractions of all known Fluids contained.

Lastly, if the Ratio were as 5 to 1, or as C A to C n, the Iris will vanish into the Sun himself; and the Colours to appearance will be inverted at its Regress to the Sun, as they were right or direct at their Egress.

And from hence it is that the Primary and Fourth Iris in Watry Clouds obverts a reddish Colour towards the Sun, but the Secondary and Third, a Purple one.

After this Mr. *Halley* shews how, having the Distance of the Iris from the Sun, to find the Ratio of the Refraction; and this by a very easy, but most accurate Observation.

Take a small Glass Tube, and erecting it perpendicular to the Horizon, suspend in its lower Orifice a small drop of Water, or some such clear Fluid; and then at some time when the Sun is near the Horizon, and shines very bright, let it be observed under what Angle *cum Opposito Solis*, the Colours of the Iris are seen in the pendulous drop; for then the Ratio of the Refraction may be had by an easy Calculation. And its Investigation forms a Cubick Equation, having only one Root, by which the Primary Iris being given, the Ratio may be found.<sup>2</sup> The Equation is this,  $T^3 - 3 T^2 t - 4 t r r = 0$ . In which, T is the Tangent of the Angle of Incidence sought, and t is the Tangent of half the Distance of the Iris *ab Opposito Solis*, to the Radius  $r = 1$ . Whence, according to *Cardan's* Rules, there arises this Theorem, viz.

From the Cube t, let there be taken the Product of  $2 t r$  into the Excess of the Secant of the same Ark above the Radius, the remainder of difference shall be the lesser Cube: But the Sum of them, adding  $4 t r r$  shall be the greater Cube. The Sum of the



the Sides of both Cubes added to  $t$ , will be equal to the Tangent of the Angle of Incidence; and the half of that Sum, the Tangent of the refracted Angle. Whence the *Ratio* of the Refraction is known.

Of this he gives the following Example.

In a drop of Oil of Turpentine, the distance of the Primary Iris *ab Opposito Solis* was observed to be  $25^{\circ} 40'$ .

The Ratio of the Refraction was required.

$$t = \text{Tangent } 12^{\circ} 50' = 0.2278063$$

$$s = \text{Secant of the same} = 1.0256197$$

$$ttt = 0.01182217$$

$$s - r \text{ into } 2rt = 0.01167265$$

Difference, Cube of the less  $0.00014952$  whose

$$\sqrt[3]{0.0530773}$$

$$\text{The Sum} = 0.02349482$$

$$\text{Adding } 4trr = 0.91122525$$

The Cube of the greater  $0.93472007$  whose

$$\sqrt[3]{0.9777486}$$

$$t = 0.2278063$$

$$1.2586322 = \text{Side of the Cube of}$$

lesser, =  $T$  The natural Tangent of the Angle of Incidence  $51^{\circ} 32'$  and its Half,

*viz.*  $0.6293161$  is the natural Tangent of the Refracted Angle, *viz.*  $32^{\circ} 11'$ .

Lastly, as  $\sqrt{T^2 + 4} : \sqrt{T^2 + 1} :: r. s.$  or so, is  $1$  to  $68026$ . Which Ratio comes very near to that which by Experiment is found to be in Glafs and most diaphanous Solids.

Only, indeed, a Diamond exceeds the rest of Pellucid Stones, in this Power of Refraction; for its Ratio is nearly as  $5$  to  $2$ , or more accurately, as  $100$  to  $41$ .

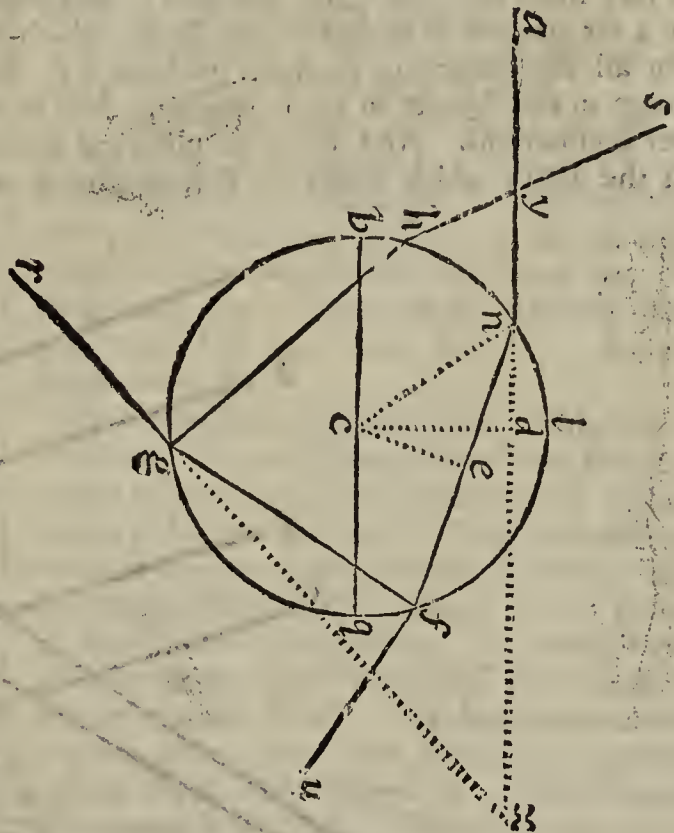
**RAIN-BOW.** In order yet further to explain the *Phænomena* of the Rain-bow; Sir *Isaac Newton* in his Excellent Treatise of Opticks, p. 126. advances this Proposition.

*By the Properties of Light (discovered by his New Experiments) to explain the Colours of the Rain-bow.*

This Bow never appears but where it rains in the Sun-shine; and it may be artificially made by spouting out Water, which by breaking aloft shall scatter into Drops, and fall like Rain; for the Sun on these Drops certainly causes the Bow to appear to an Eye duly posited to the artificial Rain, and the Sun. And hence it is now agreed, that this Bow is made by the Refraction of the Sun's Light in Drops of falling Rain. This was understood by some of the Ancients, and of late more fully discovered and explained, by *Antonius de Dominis*, A. Bp. of *Spalato* in *Libro de Radiis visus & lucis*: Printed at *Venice*, A. D. 1611. and written above 20 Years before. He shews there, how the Interior Bow is made in round Drops of Rain by a Refraction of the Sun's Light, and one Reflexion between them; and the Exterior by two Refractions and two Sorts of Reflexions between them in each Drop of Water: And he proves his Explications, by Experiments made with a Phial full of Water; and with Globes of Glafs filled with Water, and placed in the Sun,

to make the Colours of the two Bows appear in them. The same Explication *Des Cartes* hath pursued in his *Meteors*, and mended that of the Exterior Bow. But since they understood not the true Origin of Colours, its necessary to pursue it here a little further.

For understanding therefore how the Bow is made, let a Drop of Rain or any other Spherical Transparent Body be represented by the Sphere



$b n f o$  described with the Centre  $c$ , and Radius  $c n$ ; and let  $a n$  be one of the Sun's Rays incident upon it at  $n$ , and thence refracted to  $f$ ; where let it either go out of the Sphere by refraction towards  $u$ , or be reflected to  $g$ ; and at  $g$  let it either go out by Refraction at  $r$ , or be reflected to  $b$ ; and at  $b$  let it go out by Refraction towards  $s$ , cutting the Incident Ray in  $y$ : Produce  $a n$  and  $r g$  till they meet in  $x$ ; and on  $a x$  and  $n f$  let fall the Perpendiculars  $c d$  and  $c e$ ; and produce  $c d$  till it fall on the Circumference at  $l$ ; parallel to the Incident Ray draw the Diameter  $b q$ , and let the Line of Incidence out of Air into Water be to the Line of Refraction, as  $1$  to  $r$ . Now if you suppose the Point of Incidence  $n$ , to move from the Point  $b$  continually till it come to  $l$ , the Arch  $q f$  will first increase and then decrease, and so will the Angle  $a x r$ , which the Rays  $a n$  and  $g r$  contain: And the Arch  $q f$ , and Angle  $a x r$  will be

biggest when  $n d$  is to  $c n ::$  as  $\sqrt{11 - rr}$  is to  $\sqrt{3 rr}$ ; in which case  $n e$  is to  $d n$ , as  $2 r$  to  $1$ . Also the Angle  $a y s$ , which the Rays  $a n$  and  $b s$  contain, will first decrease and then increase, and grow less, when  $n d$  is to  $c n ::$   $\sqrt{11 - rr}$  is to  $\sqrt{8 rr}$ : In which case  $n e$  will be to  $n d ::$  as  $3 r$  to  $1$ , and so the Angle which the next emergent Rays, *viz.*  $y$ , after 3 Reflections, contains with the incident Ray  $a n$ , will come to its limit when  $n d$  is to  $c n ::$  as  $\sqrt{11 - rr}$  is to  $\sqrt{15 rr}$ ; and  $n e n d ::$  as  $4 r$  to  $1$ , and the Angle with the Ray next after the emergent, (*i. e.* the Ray emergent after 4 Reflexions) contains with the Incident Ray, will come to its Limit when  $n d$  is to  $c n ::$  as  $\sqrt{11 - rr}$  is to  $\sqrt{24 rr}$ ; in which Case  $n e$  will be to  $n d ::$  as  $5 r$  to  $1$ ;

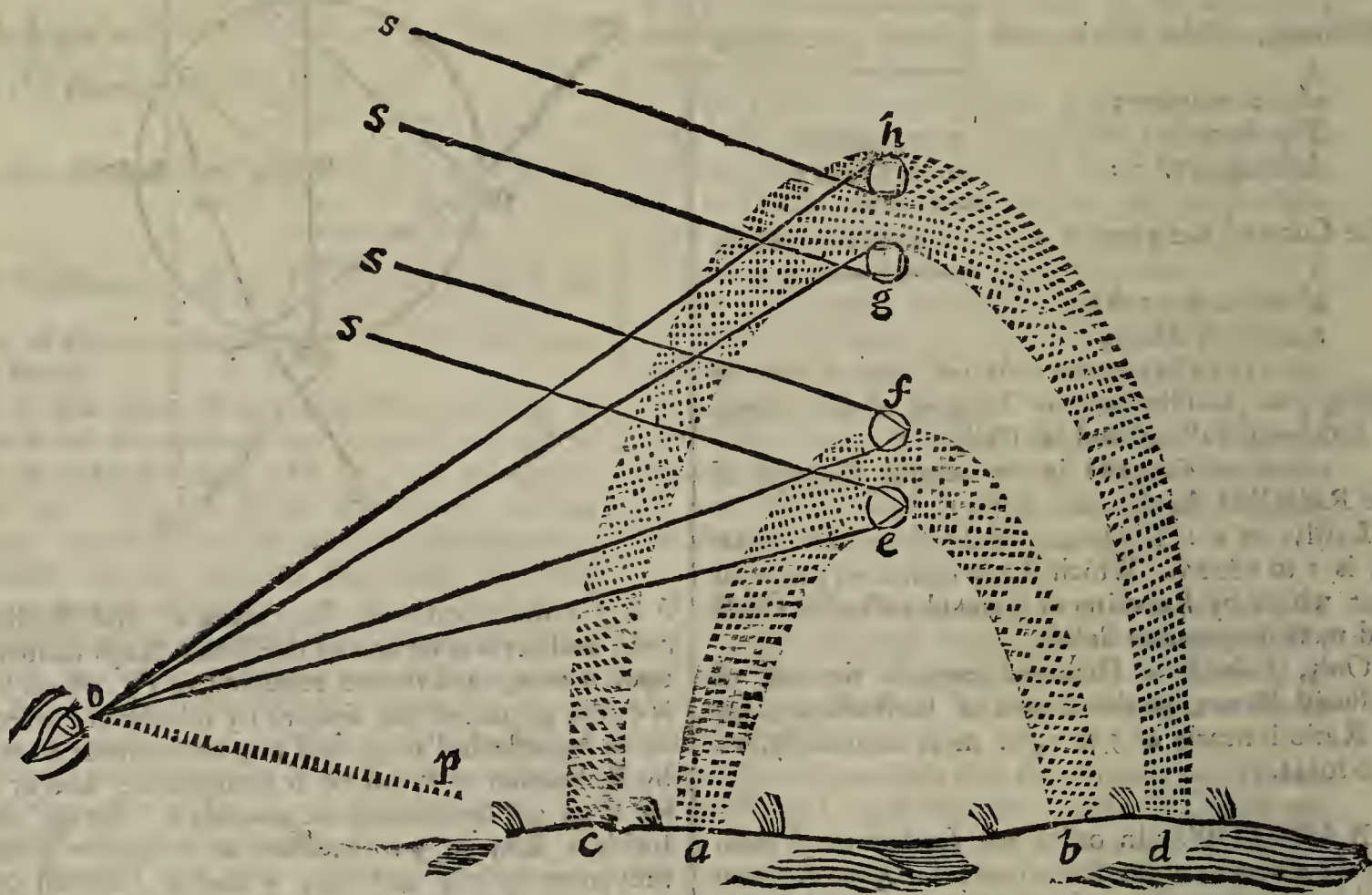


5  $r$  to 1; and so on infinitely: The Numbers 3, 8, 15, 24, &c. being gathered by continual Addition of the Terms of the Arithmetick Progressions 3, 5, 7, 9, &c. The Truth of all which Mathematicians will easily examine.

Now it is to be observed, that as when the Sun comes to his Tropicks, the Days increase and decrease but a very little for a great while together; so when by increasing the Distance  $cd$ , these Angles come to their Limits, they vary their Quantity but very little for some time together; and therefore a far greater Number of the Rays which fall upon all the Points  $n$ , in the Quadrant  $bl$ , shall emerge in the Limits of these Angles, than in any other Inclinations. And 'tis to be observed farther, that the Rays which differ in Refrangibility will

have different Limits of their Angles of Emergence, and consequently according to their different Degrees of Refrangibility, emerge most copiously in different Angles, and being separate from one another, appear each in their proper Colours. And what these Angles are, may be easily gathered from the foregoing Theorem, by Computation.

For in the least refrangible Rays the Sines 1 and  $r$  (as was found above) are 108 and 81, and thence by Computation the greatest Angle  $axr$  will be found  $42^{\circ} 2'$ , and the least Angle  $ays$   $50^{\circ} 57'$ . And in the most refrangible Rays, the Sines 1 and  $r$ , are 109 and 81; and thence by Computation the greatest Angle  $axr$  will be found to be  $40^{\circ} 17'$ ; and the least Angle  $ays$   $54^{\circ} 7'$ .



Supposing now then  $o$  be the Spectator's Eye, and  $op$  a line drawn parallel to the Sun's Rays, and let  $poe$ ,  $pod$ ,  $pod$ , and  $po h$ , be Angles of  $40^{\circ} 17'$ ,  $42^{\circ} 2'$ ,  $50^{\circ} 57'$ , and  $54^{\circ} 7'$  respectively; and these Angles turned about their common side  $op$ , shall with their other sides  $oe$ ,  $of$ ,  $og$ , and  $oh$ , describe the Verges of 2 Rain-bows  $afbe$ , and  $chdg$ : For if  $e$ ,  $f$ ,  $g$ ,  $h$ , be Drops placed any where in the Conical Surfaces described by  $oe$ ,  $of$ ,  $og$ ,  $oh$ , and be illuminated by the Sun's Rays  $se$ ,  $sf$ ,  $sg$ ,  $sh$ : The Angle  $seo$  being equal to the Angle  $poe = 40^{\circ} 17'$ , shall be the greatest Angle in which the most refrangible Rays can after one Reflexion be refracted to the Eye: And therefore all the Drops in the Line  $oe$ , shall send the most refrangible Rays most copiously to the Eye, and thereby strike the Senses with the *deepest violet Colour* in that Region. And in like manner the Angle  $sfo$  being = to the Angle  $pod = 42^{\circ} 2'$ , shall be the greatest in which the least refrangible Rays after one Reflexion can emerge out of the Drops; and that these Rays shall come most copiously to the Eye from the Drops in the Line  $of$ , and strike the Senses with the *deepest red Colour* in that Region. And by the same Argument, the Rays which have intermediate Degrees of Refrangibility, shall come most copiously from Drops

between  $e$  and  $f$ , and so strike the Senses with the intermediate Colours, in the Order which their Degrees of Refrangibility require: *i. e.* in the Progress from  $e$  to  $f$ , or from the Inside of the Bow to the Outside in this Order; Violet, Indico, Blue, Green, Yellow, Orange, Red. But the Violet, by the mixture of the white Light of the Clouds, will appear faint, and incline to a Purple.

Again, the Angle  $sgo$  being equal to the Angle  $pod$ , or  $50^{\circ} 57'$ , shall be the least Angle in which the then *least* refrangible Rays can, after 2 Reflexions emerge out of the Drops; and that the least refrangible Rays shall come most copiously to the Eye from the Drops in the Line  $og$ , and strike the Sense with the *deepest Red* in that Region. And the Angle  $sho$  being equal to  $po h = 54^{\circ} 7'$ , shall be the least Angle in which the *most* refrangible Rays, after 2 Reflexions can emerge out of the Drops; and that those Rays shall come most copiously to the Eye from the Drops in the Line  $oh$ , and so strike the Senses with the *deepest Violet* in that Region. And by the same Argument, the Drops in the Regions between  $g$  and  $h$ , shall strike the Senses with the intermediate Colours, in the Order which their Degrees of Refrangibility require (*i. e.*) in the Progress from  $g$  to  $h$ , or from the inside of the Bow



Bow to the outer, in this Order: Red, Orange, Yellow, Green, Blue, Indico, Violet. And since these 4 Lines *o e*, *o f*, *o g*, *o h*, may be situated any where in the above mentioned Conical Surface, what is said of the Drops and Colours in these Lines, is to be understood of the Drops and Colours every where in these Superficies.

Thus shall there be made two Bows of Colours, an interior and stronger, by one Reflexion in the Drops, and an exterior and fainter by two; for the Light becomes fainter by every Reflexion: And their Colours shall lie in a contrary Order to one another, the Red of both Bows bordering upon the Space *g f*, which is between the Bows. The Breadth of the interior Bow *f o e*, measured a-cross the Colours shall be  $1^{\circ} 45'$ , and the breadth of the exterior *g o h*, shall be  $3^{\circ} 10'$ ; and the Distance between *g o f*, shall be  $8^{\circ} 55'$ . The greatest Semidiameter of the innermost, (*i. e.*) the Angle *p o f* being  $42^{\circ} 2'$ ; and the least Semidiameter of the outermost *p o g* being  $50^{\circ} 57'$ . These are the Measures of the Bows, supposing the Sun to be a Point; but by the breadth of his Body, the breadth of the Bows will be increased, and their Distance decreased by half a Degree.

This Explication of the Rain-bow is yet farther confirmed, by the known Experiment of hanging up in the Sun-shine a Glass-globe filled with Water; and then viewing it in such a Posture, that the Rays which come from the Globe to the Eye may contain with the Sun's Rays an Angle of either 42 or 50 Degrees: For if the Angle be about 42 or 43 Degrees, the Spectator suppose at *o* (in the preced. Fig.) shall see a full red Colour in that side of the Globe which is opposed to the Sun, as is represented at *f*. And if that Angle become less (suppose by depressing the Globe to *e*) there will appear other Colours, Yellow, Green and Blue successively, in the same side of the Globe. But if the Angle be made about 50 Degrees, (as suppose by lifting up the Globe to *g*,) there will appear a red Colour in that side of the Globe which is towards the Sun: And if the Angle be made greater, (suppose by lifting up the Globe to *h*) the Red will turn successively to the other Colours, Yellow, Green, Blue, &c. The same thing may be done (as the Author tried) letting the Globe rest, and only raising and depressing the Eye, or moving it so, as to make the Angle of a just Magnitude.

*Marine RAINBOW* a Phenomenon sometimes observed in a much agitated Sea, when the Wind sweeping part of the tops of the Waves carries them aloft; so that the Sun's Ray falling upon them are refracted, &c. as in a common Shower, and paint the Colours of the Bow; some Authors have observed that the Colours of this Bow are less lively, distinct and of a less Duration than those of the common Bow are; and that there are scarce more than two Colours distinguishable, *viz.* a dark Yellow on the Side next the Sun, and a pale Green on the opposite Side, but these *Marine Bows* appear in a Position opposite to the common Bow; *i. e.* the Concave Side is turned upwards and also appear in Number, there being sometimes 20 or 30 seen together and that at Noon Day.

**RAINS:** Our Seamen call the Tract of the Sea to the Northwards of the Equator betw. 4 and 10 Degrees of Latitude, and lying between the Meridian of *Cape Verde*, and that of the Eastermost Islands of the same Name, or of the *Cape Verde* Islands, they call this Tract the *Rains*: Because

there are almost continual Calms, constant Rains, and Thunder and Lightning to a strange Degree there; and the Winds, when they do ever blow, are only small uncertain Gusts, and shift about all round the Compass; so that Ships are sometimes here detained a long while, and can make but very little way.

**RANDEZVOUS**, in a Military Sense, is a Place appointed by the General of an Army, for all the Forces to meet on a Day appointed; let what Weather, &c. happen that will.

**RAISER** [in *Building*] a Board set an edge under the fore-side of a Step or Stair.

**RAKE of a Ship**, is so much of her Hull as overhangs at both ends of her Keel. The part of it which is before, is called her *Rake forward on*; and that part which is at the setting on of the Stern-Post, is called her *Rake aft-ward on*: When a Ship hath but a small *Rake forward on*, but is built with her Stern too strait up, she is called *Bluffe-headed*.

The common Proportion for a Ship's *Rake forward on*, is more than a Third, but less than  $\frac{1}{2}$  the length of her Keel: and the *Rake aft* is about a 4th or 5th of her *Rake before*. Tho' in this Proportion, there is no certainty, some Nations, and some Carpenters building with longer *Rakes* than others. A *Long Rake forward on*, if a Ship have also a good far Bow, gives her a good Way, and helps her to keep a good Wind; but then this makes her apt to pitch under Water in a Head-Sea, and besides is a great Stress and Charge to a Ship, because she overhangs so a Head. Therefore the middle Proportion is best, considering all things.

**RAKE of the Rudder.** See *Rudder*.

**RAKED Table**, a Term in Architecture. See *Table*.

**RAM Head**, is the Name of a great Block (aboard a Ship) belonging to the Fore and Main-Halliards; it hath in it 3 Shivers, into which the Halliards are put, and at its Head the Tyes are reeved into an Hole made there for that Purpose.

**RAMIFICATION**, is a Collection of small Branches issuing out from one large one. Thus in *Anatomy*, the several Branches of the *Aorta* or *Great Artery*, by which the Arterial Blood is convey'd to all the extream Parts of the Body, are called the *Ramifications* of the Artery; and when they are exceeding small, they are called *Capillary Arteries*; which see.

**RAMMER**, is a Staff with a round piece of Wood at one end, in order to drive home the Powder to the Breech of the Great Gun, as also the Shot and the Wad, which keeps the Shot from rowling out. At the other end of these *Rammers*, are usually rolled in a certain Piece of Ships-skin fitted to the Bore of the Piece, in order to clear her after she has been discharged: And this is called Spunging the Piece.



**RAMPANT:** the Term in Heraldry for a Lion, or any Beast of Prey, in a Posture of Climbing, or Standing upright on his hinder Legs, and rearing up his Fore-feet, 'Tis different from *Salient*, which is a Posture not so erect. See *Salient*.



**RAMPART**, in Fortification, is the Mass of Earth which is raised about the Body of any Place, to cover it from Great Shot, and consists of several *Bastions* and *Curtains*; having its *Parapet*, *Platform*, *interior* and *exterior Talus*, and *Berme*, as also sometimes a Stone Wall, and then they say it is Lined. The Soldiers continually keep Guard here, and Pieces of Artillery are Planted for the Defence of the Place.

The Height of the *Rampart* must not exceed three Fathom, as being sufficient to cover the Houses from the Batteries of the Cannon: Neither ought its Thickness to be above ten or twelve, unless more Earth be taken out of the Ditch, than can be otherways bestowed.

The *Ramparts* of Half-Moons are the better for being low, that the small Fire of the Defendants may the better reach the Bottom of the Ditch; but yet it must be so high, as not to be commanded by the Covert-way.

**RAMUS Anterior**, *Sc. Venæ Subcutaneæ*, is a Branch of the *Subcutaneous* Vein, (which takes its Name from its shallow running just under the Skin) and is it self a Branch of the *Basilica*; it goes under the Muscles of the *Ulna* to the little Finger, where it joins a Branch of the *Cephalica*.

**RAMUS Posterior**, another Branch of the *Subcutaneous* Vein of the Arm, running near the Elbow; it sends out a Branch which goes to the Wrist, then it unites with the *Cephalica Interior*, and forms the *Mediana*.

**RANDOM Shot**, is a Shot made when the Muzzle of a Gun is raised above the Horizontal Line, and is not designed to shoot directly or Point-blank. The utmost *Random* of any Piece, is about ten times as far as the Bullet will go Point-blank; and the Bullet will go farthest when the Piece is mounted to about 45 Degrees above the Level-Range. The Distance of the *Random* is reckoned from the Platform to the Place where the Ball first Grazes.

**RANGE**, a Term in Gunnery, signifying the Line a Shot goes in from the Mouth of the Piece. If the Bullet go in a Line parallel to the Horizon, that is called the *Right* or *Level-Range*; if the Gun be mounted to 45 Degr. then will the Ball have the highest or utmost Range, and so proportionably all others between 00 Degr. and 45°, are called the *Intermediate Ranges*.

**RANGES**, in a Ship, are two Pieces of Timber going a-crofs from Side to Side; one aloft on the *Fore-Castle* a little abaft the *Foremast*; and the other in the *Beak-Head* before the *Woundings* of the *Bow-Sprit*.

That in the *Fore-Castle*, is fastened into the Timbers of the Ship's Sides, and hath two Knees about the Middle, on either Side the *Foremast*, fastened to the Deck and the Timber, in which the *Top-Sail-Sheets* run in a Shiver: In it also are several Wooden Pins to belay the *Fore-bowling*, the *Fore-Tack*, and the *Fore-loof Hook*.

That in the *Beak-Head* lies in the Form of the orher, and hath the *Sprit-Sail*, and *Sprit-Sail-Top-Sail-Sheets* and Ropes belayed about its Pins.

**RANGER**, is a Sworn Officer of the Forest, whereof there are Twelve: His Business chiefly consists in three Points; To walk daily through his Charge, to see, hear, and enquire, as well of Trespasses, as Trespassers in his Bailiwick; To drive the Beasts of the Forests, both of Venerly and Chase, out of the Disforested into the Forested Lands; And, To present all Trespasses of the

Forest. This *Ranger* is made by the King's Letters-Patent, and hath yearly Pension out of the *Exchequer*.

**RANK**, in a Military Sense is the Order or strait Line made by the Soldiers of a Battalion, or Squadron drawn up side by side, *Doubling of Ranks* is putting two into one.

**RANULA**. See *Hypoglossum*.

**RANULARES**, are those Branches of the external Jugular Veins which run to the Tongue, and are very apparent under it.

**RAPACIOUS Animals**, are in general such as live upon Prey: And 'tis a general Division of Birds, into such as are *Rapacious* and *Carnivorous*, and such as are *Frugivorous*. The Characteristick notes of Birds of Prey are; that they have a great Head and a short Neck, hooked, strong and sharp pointed Beak and Talons, fitted for rapine and tearing of Flesh; strong and brawny Thighs for striking down their Prey: A broad thick fleshy Tongue like that of a humane Creature; 12 Feathers in their Train; and 14 flag Feathers in each Wing. The two *Appendices*, or blind Guts, are always very short; They have a *Membranous* Stomach, and not a *Musculous* one or a *Gizzard*, such as Birds have that live on Grain: They are very sharp-sighted, and are not *Gregarious*, but Solitary generally speaking, though Vultures will fly 50 or 60 in a Company.

**RAPHA**, in Anatomy, is a Ridge or Line which runs along the Under-side of the *Penis*, and reaching from the *Frenum* to the *Anus*, divides the *Scrotum* and *Perineum* in two. This line is not usually cut in the Grand Operation of cutting for the Stone, because 'tis both harder than the rest of the Skin thereabouts, and also because you must then cut upon the Interstices of the Muscles, which will make the Re-union the more difficult.

**RAPHE**. See *Satura*.

**RAPINE**, in Law; to take a Thing in private against the Owner's Will, is properly Theft; but to take it openly, or by Violence, is *Rapine*.

**RAPSODY**, *ῥαψωδία* originally signifies a Connection together, or a Repetition of a vast Number of Heroick Verses, such as those of *Homer*, &c. But now we usually understand by it, a long, tedious, impertinent spinning out of a Discourse to little or no Purpose, or Benefit to the Reader.

**RAPTU Hæredis**; is a Writ lying for the taking away of an Heir holding in Soccage; of which there are two Sorts; one when the Heir is Married, the other when he is not. Of both these, see the *Reg-Orig. Fol. 163*.

**RARE Bodies**, are such as have more Space, or take up more Room in Proportion to their Matter, than other Bodies do.

**RAREFACIENTIA**, rarifying Remedies, are such as by dissipating a little the Vapours and Humours, make the Pores of Bodies larger. *Blanchard*.

**RAREFACTION**, of any natural Body, is when it takes up more Dimensions, or a larger Space than it had before.

There are three Ways of Explicating of Rarefaction.

1. That of the *Aristotelians*, which is called the Rigorous Way, who suppose the same Body doth not only obtain a greater Space in Rarefaction, but also adequately fill it; and acquires larger Dimensions, without either having any Pores or Vacuities between its Corpuscles, or admitting any other Body or subtle Matter to be joined with them.

2. That



2. That of the *Cartesians*, which was also the Opinion of many of the Old Philosophers, who assert, That in Rarefaction the Pores of the rarefied Body are dilated, and replenished with some fine subtle and ethereal Substance, which insinuates it self freely into the Interstices between its disjoined Particles.

3. That of the *Atomists* or *Vacuists*, who suppose the Parts of the rarefied Body to be disjoined and removed farther from each other, and yet no other Body (necessarily) comes in between them: See this explained under *Air*.

**RAREFACTION**, in Physics, the Action whereby a Body is render'd Rare; that is, whereby it comes to possess more room, or appear under a larger Bulk, without any Accession of new Matter.

*Rarefaction* is oppos'd to *Condensation*.

In Strictness, however, our more accurate Writers restrain *Rarefaction* to that Expansion of Mass into a larger Bulk, which is effected by means of Heat; all Expansion from other Causes they call Dilatation.

The *Cartesians* deny any such as absolute *Rarefaction*, Extensions, with them, constituting the Essence of Matter, they are obliged to hold all Extension equally full.

Hence, they make *Rarefaction* to be no other than an Accession of fresh, subtle, and insensible Matter, which entering the Parts of a Body, sensibly distends them.

'Tis by *Rarefaction* that Gunpowder has its Effects; and to the same Principle we owe our *Æolipyls*. *Thermometers*, &c.

The Degree to which the Air is rarefyable exceeds all Imagination; *Mersennius*, long ago, by means of an intense Heat, found that the Air might be rarified, so as to possess more than 70 times its former Space.

Mr. *Boyle* afterwards found, that Air by its own Elasticity, and without the help of any Heat, would dilate its self so as to take up 9 times its former Space; then 31 times; then 60; then 150; at length, by many Degrees he found it would reach to 8000 times, then 10000, then 13679.

Such is the *Rarefaction* of common Air, from its Principle of Elasticity, and without previous *Condensation*; but if it be compress'd, the same Author found its greatest Space when most rarified, is to its least when most condens'd, as 550000 to 1.

Such an immense *Rarefaction*, Sir *Isaac Newton* shews, is inconceivable on any other Principle than that of a repelling Force inherent therein, whereby its Particles mutually fly from one another.

This repelling Force he observes is much more considerable in Air than in other Bodies, as being generated from the most fix'd Bodies, and that with Difficulty, and scarce without Fermentation, those Particles being always found to fly each other with the most Force, which, when in Contact, cohere the most firmly.

The Members of the *French* Royal Academy have bestowed a world of Attention on the different *Rarefactions*, or rather the different Rarities of the Air at different Heights, Mr. *Mariotte* established this as a Principle, from Experiments that the different *Rarefactions* or *Condensations* of the Air follow the Proportion of the Weights wherewith 'tis press'd.

Hence, supposing the *Mercury* in the level of the Sea suspended to 28 Inches, which is the Weight of the whole Atmosphere; and that 60

Foot Height of Air are equivalent to a Line, or  $\frac{1}{12}$  of an Inch of *Mercury*; so that the Barometer at the Height of 60 Foot from the Sea, would fall a Line; 'tis easy finding what Height of Air would be equal to a Second, or any other Line of *Mercury*. For as 28 Inches of *Mercury*,  $\frac{1}{12}$  are to 28 Inches, so is the Height of 60 Foot of Air, to a fourth Term; which is the Height of Air corresponding to a Second Line of *Mercury*.

And after the same Manner may the Heights of Air corresponding to each Line be found; which will make a Geometrical Progression, the Sum whereof will be the whole Height of the Atmosphere, of consequence a certain Part of that Sum will be the Height of a Mountain; at whose Top a Barometer shall have sunk a certain Quantity.

Mess. *Cassini* and *Maraldi*, upon measuring the Heights of several Mountains, found that this Progression of Mr. *Mariotte*, was defective; that it always gave the Height of the Mountains, and consequently the *Rarefactions*, less than they really were; and from some new Experiments, Mr. *Amon-ton* found that the Principle will only hold in the mean *Rarefactions*, not in the Extremes.

**RAREFACTIVES** } [in *Medicine*] Reme-

**RAREFACIENTIA** } dies which open and enlarge the Pores of the Skin, in order to give an easy Vent to the matter of Perspiration.

**RASANT** *Line of Defence*, in Fortification, is a Line drawn from the Point of the Bastion along the Face; and prolonged till it come to the Curtain, and therefore shews how much of the Curtain will clear or scour the Face. This is called also the Second Flank, the Hanking, or Stringent Line.

**RASSETTA**, the same with *Carpus*.

**RASH**. See *Ratch*.

**RASPATORIUM**, or *Scalprum Rasorium*, is a Chirurgion's Instrument to scrape or shave filthy or scabby Bones with.

**RATCH**, is a sort of a Wheel of 12 large Fangs, that runneth Concentric to the Dial Wheel, and serveth to lift up the *Dentes* every Hour, and make the Clock strike: and are by some called *Rash*.

**RATCHET**, in a Watch, are the small Teeth at the Bottom of the Fusy or Barrel; that stop it in winding up.

**RATE-Tytte**, is when Sheep or other Cattle are kept in a Parish for a less Time than a Year, the Owner must pay *Tytte* for them *pro rata*, according to the Custom of the Place.

**RATE** of a Ship of War is its distinction as to Bigness and Capacity; and this is usually accounted by the Length and Breadth of the Gun-deck, the Number of Guns they contain, and the Number of Men and Guns they carry. For such Men of War as have their Gun-decks from 159 to 174 Feet in length, and from 44 to 50 Feet broad: That contain from 1313 to 1882 Tuns, that have from 706 to 800 Men, and carry from 96 to 110 Guns: We reckon of the *First Rate*.

*Second Rate Ships*, have their Gun-decks from 153 Feet to 165 Feet long; and from 41 to 46 broad: Contain from 1086 to 1482 Tuns; and carry from 524 to 640 Men, and from 84 to 90 Guns.

*Third Rates* have their Gun decks from 142 to 158 Feet in length; from 37 to 42 Foot broad: They contain from 871 to 1262 Tuns; carry from 382 to 476 Men, and from 64 to 80 Guns.



*Fourth Rates* are in length on the Gun-deck from 118 to 146 Foot, and from 29 to 38 broad: They contain from 448 to 915 Tuns; carry from 226 to 346 Men, and from 48 to 60 Guns.

*Fifth Rates* have their Gun-decks from 100 to 120 Foot long, and from 29 to 31 Feet broad: Contain from 259 to 542 Tuns; carry from 145 to 190 Men, and from 26 to 44 Guns.

*Sixth Rates* have their Gun-decks from 87 to 95 Foot long, and from 22 to 25 Foot broad: They contain from 152 to 256 Tuns; carry from 50 to 110 Men, and from 16 to 24 Guns.

Our New-built Ships are much larger, as well as better, than the old Ones of the same *Rate*; and that is the Reason of the double Number all along; the larger of which expresses the Proportions of the New-built Ships.

**RATIFICATION**, a Law-Term, used for the Confirmation of a Clerk in a Prebend, &c. formerly given him by the Bishop, &c. where the Right of Patronage is doubted to be in the King.

**RATIO**. When two Quantities are compared one with another in respect of their Greatness or Smallness. That *Comparison* is called *Ratio*, and signifies the *Rate*, *Reason* or *Proportion* in Quantity, that one hath to the other. Though some, indeed, confine Ratio or Reason only to two Numbers, and call it *Proportion*, when it is between 3, 4, or more Numbers or Quantities. But the Word *Proportion* is often used instead of Ratio or Reason, to express the Comparison of one single Quantity to another, by very good Authors.

*Rational* **RATIO**, is that which is as one Rational Number to another, *e. g.* as 3 to 4.

*Irrational* **RATIO**, is that which cannot be expressed by Rational Numbers.

**RATIONABLES**, *Expenses*, the Commons of the Parliament, as well as the Proctors of the Clergy in Convocation were allow'd their *reasonable Expenses*, *i. e.* such Allowance as the King considering the Price of all Things, shall judge meet to impose on the People, to pay for the Subsistence of their Representatives. Thus in the 17th of *Edward II.* there was 10 Groats a Day for Knights, and 5 for Burgeesses, afterwards 4 Shillings a Day for Knights, and 2 for Burgeesses, which was then accounted a sufficient and ample Reward for Expenses, Labour, Attendance, neglect of their own Affairs, &c.

**RATIOCINATION**, a Rational way of Arguing.

**RATIONABILI parte bonorum**, is a Writ that lies for the Wife against the Executors of her Husband, denying her the third Part of her Husband's Goods.

**RATIONABILIBUS divisis**, is a Writ that lies where two Lords in divers Towns, have Seignories joining together, for him that findeth his Waste by little and little to have been encroached upon, against the other that hath Encroached, thereby to rectify their Bounds. And this is a King of *Justices*, and may be removed by a *Pone*, out of the County to the Common Bench. By the *Civilians* it is called *Judicium finium Regundorum*.

**RATIONAL Horizon**. See *Horizon*.

**RATIONAL Quantities**. Any Quantity being proposed, (for which we may always put 1.) and which *Euclid* (Book 10.) calls *Rational*, there may be infinite others which are Commensurable, or Incommensurable to it; and that either Simple, or in

Power. Now, all such as are Commensurable any how to the given Quantity, he calls Rational Quantities, and all the others Irrational.

**RATIONAL Integer** or *whole Number*, is that of which Unity is an aliquot Part.

**RATIONAL Fraction** or *Broken Number*, is that which is equal to some aliquot Part or Parts of Unity.

**RATIONAL mixt Numbers**, is that which consists of an Integer and a Fraction, or of an Unity and a broken Number.

**RATIONAL Ratio** is a Ratio, the Terms of which are rational Quantities, or a Ratio which is as one rational Number to another, *e. g.* as 3, to 9.

**RATIONALE** an Account or Solution of some Opinion, Action, Hypothesis, Phænomenon, or the like on Principles of Reason.

**RATIONIS** as [in *Anatomy*] the Bone of the Forehead, otherwise called *os frontis*.

**RATION**, is now in the Army, a word in use for a certain Proportion of Ammunition-Bread, or Forrage distributed to every Man in the Army, as his Portion for such a Time.

**RATLINES**, (or as the Seamen call them, *Ratlings*) are those Lines which make the Ladder Steps, to get up the Shrouds and Puttocks; therefore they are called the Ratlings of the Shrouds.

**RAVELIN**, in Fortification, is a small Triangular Work composed only of two Faces, which make a Salient Angle, without any Flanks. It is generally raised before the Curtains or Counter-scarp, and commonly called a Half-Moon by the Soldiers.

A *Ravelin* is like the Point of a Bastion with Flanks cut off. The Reason of its being placed before a Curtain, is to cover the opposite Flanks of the two next Bastions. 'Tis used also to cover a Bridge or a Gate; and 'tis always placed without the Moat.

What the Engineers call a Ravelin, the Soldiers generally call a Half-Moon, which see.

**RAVISHMENT de Garde** was a Writ that formerly lay for the Guardian by *Knights Service*, or in *Soccage*, against him that took away from him the Body of his Ward.



**RAVISSANT** [in *Heraldry*] is a Term used to express the Posture of a Wolf half raised, as it were just springing forwards upon his Prey; see the Figure.



**RAYONNANT** [in *Heraldry*] signifies darting forth Rays, as the Sun does when it shines out. So a *Cross Rayonnant* is one which has Rays of Glory behind it, darting out from the Center to all the Quarters of the Escutcheon, as in the Figure.

**RAY** Common is a right Line drawn from the Point of the Concourse of the two Optical Axes, through the middle of the right Line which passeth by the Centre of the Pupil of the Eye.

**RAY** Direct, is that which is carried from a Point of the visible Object directly to the Eye, through one and the same Medium.



RAY of Incidence, or Incident Ray, in Catoptricks, is a right Line, which falls from some Point of an Object upon the Surface of the Looking-Glass or polished Metal.

RAY of Incidence, or Incident Ray, in Dioptricks, is the Ray of Light which goes in a right Line from a certain Point of the visible Object in one Medium, until it meet with a Second Medium.

RAY in Opticks, is a Line imagined to pass from the Eye towards the Object, or from the Object towards the Eye, and is called a Visual Ray. But there is also a Pyramid of Rays, which strike the *Tunica Retina* of the Eye, and are broken or refracted in the Chryselline.

RAYS of Light with Regard to Opticks, are by Sir *Is. Newton* considered, as the last Parts of that wonderful Fluid; and that as well such as are successive in the same Lines as contemporary in several Lines: For 'tis manifest that Light consists of Parts both successive and contemporary; because in the same place you may stop that which comes one moment, and let pass that which comes presently after, and in the same Time you may stop it in any one place, and let it pass in another. Wherefore the least Light, or part of Light, which may be stoppt alone without the rest of the Light; or propagated alone, or do or suffer any thing alone, which the rest of the Light does not, or suffers not, he calls a Ray of Light.

The Mathematicians indeed usually consider the Rays of Light to be Lines reaching from the luminous Body to that illuminated; which were just if Light were propagated in an instant, as some have supposed: But the Observations of the Eclipses of *Jupiter's* Satellites made first by Mr. *Romer*, do shew that 'tis propagated in Time, and in particular that it takes up about 7 Minutes in moving from the Sun to the Earth.

The incomparable Sir *Is. Newton* in his Opt. Book 2. Part 3. p. 65. After having premised p. 50. that those Surfaces of transparent Bodies reflect the greatest Quantity of Light, which have the greatest Refracting Power; and also that in the Confines of equally refracting Mediums there is no Reflexion; and at pag. 45. That the Transparent parts of Bodies according to their several Sizes must reflect Rays of one Colour, and transmit those of another on the same Grounds, that thin Plates or Bubbles do transmit or reflect those Rays; which he takes to be the ground of all their Colours: proceeds, in the Eighth Proposition, to enquire into the Cause of the Rays of Lights being reflected, and he shews that the Cause of Reflexion is not the impinging of Light on the solid or impervious Parts of Bodies as hath commonly been believed, as appears from the following Considerations,

(1) That in the Passage of Light out of Glass into Air, there is a Reflexion as strong as in its Passage out of Air into Glass, and rather something stronger, and much stronger than in its Passage out of Glass into Water: And it seems not probable that Air should have more reflecting Parts than Water or Glass. But if that could be supposed it would not do, because the Reflexion is as strong or stronger when the Air is drawn away from the Glass (as suppose in the exhausted Receiver of Mr *Boyle's* Air pump) as when it is adjacent to it.

(2.) If Light in its Passage from Glass to Air be incident more obliquely than an Angle of 40 or 41

gr. it is wholly reflected; but if less obliquely, it is in a great Measure transmitted. Now it is not to be imagined that Light at one Degree of Obliquity should meet with Pores enough in the Air to transmit the greatest Part of it, and at another Degree of Obliquity should meet with nothing but Parts to reflect it wholly; especially considering that in its Passage out of the Air into Glass, how obliquely soever it falls, it finds Pores enough in the Glass to transmit the greatest Part of it. If it be said that it is not reflected by the Air but by the utmost Superficial Parts of the Glass; there is still the same Difficulty: Besides, that such a Supposition is unintelligible, and will also appear to be false by applying Water behind some part of the Glass instead of Air. For so in a convenient Obliquity of the Rays, as suppose of 45 or 46 gr. at which they are all reflected, where the Air is adjacent to the Glass, they shall be in a great Measure transmitted where the Water is adjacent to it: Which argues, that their Reflexion or Transmission depends on the Constitution of the Air and Water behind the Glass, and not on the striking of the Rays upon the Parts of the Glass.

(3.) If the Colours made by a Prism placed at the Entrance of a Beam of Light into a darkned Room, be successively cast on a second Prism placed at a greater Distance from the former, in such manner that they are all alike incident upon it; the second Prism may be so inclined to be Incident Rays, that those which are of a blue Colour shall all be reflected by it, and yet those of a red Colour pretty copiously transmitted. Now if the Reflexion be caused by the Parts of Air and Glass, how comes the Blue, at the same Obliquity of Incidence, wholly to impinge on those Parts so as to be all reflected, and yet the Red find Pores enough to be in a great Measure transmitted?

(4.) Where 2 Glasses touch one another, as he shews in the first Observation, there is no sensible Reflexion, yet why should not the Rays of Light impinge on the Parts of Glass, as much when contiguous to other Glass, as when so to Air?

(5.) When the Top of a Bubble of Water in Obs. 17. at last began to grow very thin, there was so very little Light reflected from it, that it appeared intensely black; and yet round about where the Water was thicker, the Reflexion was so strong as to make the Water to appear very white

Nor is it only at the least Thickness of Bubbles and thin Plates that there is no manifest Reflexion, but at many others continually greater and greater: For he found (in Obser. 15.) that Rays of the same Colour were by turns transmitted at one Thickness; and reflected at another, for an indeterminate Number of Successions; and yet in the Surface of the thinned Body, where it is of any one Thickness, there are as many Parts for the Rays to impinge on, as where it is of any other Thickness.

(6.) If Reflexion were caused by the Parts of reflecting Bodies, it would be impossible for thin Plates or Bubbles at the same place to reflect the Rays of one Colour and transmit those of another, as by the 13 and 15 Observations 'tis plain they do: For it is not to be imagined that at one Place the Rays which (for instance) exhibit a Blue, should have the Fortune to dash upon the Parts; and those which exhibit a Red should fall upon the Pores of the Body: And then at another Place, where the Body is either a little thicker or thinner; that



that on the contrary, the *Blue* should fall on its *Pores*; and the *Red* upon its *Parts* polished.

(7.) Were the Rays of Light reflected by impinging on the solid Parts of the Bodies, their Reflexions from these Bodies could not be so regular as they are. For in polishing with Sand, Glass, Putty, or Tripoly; it is not to be imagined that those Substances can by grating and fretting the Glass, bring all its least Particles to an accurate Polish, so that all their Surfaces shall be truly plane or truly spherical, and look all the same way, so as together to compose one even Surface. The smaller indeed the Particles of these Substances are, the smaller will the scratches be, by which they continually fret and wear away the Glass until it be polished: But be they never so small they can wear away the Glass no otherwise than by grating and scratching it, and breaking off the Protuberances; and they polish it no otherwise than by bringing its roughness to a very fine Grain, so that the Scratchings upon it become too small to be visible. And then if Light were reflected by impinging upon the solid Parts of the Glass, it would be scattered as much by the most polished Glass as by the roughest: Wherefore it remains a Problem, how Glass polished by fretting Substances can reflect Light so regularly as it doth; and this can't well be solved, unless the Reflexion of the Ray be effected, not by a single Point of the reflecting Body, but by some Power of the Body which is evenly diffused all over its Surface, and by which it acts upon the Ray without immediate contact, for that the Parts of Bodies do act on Light at a distance, he shews in another Place. (See *Light*.) And if Light be reflected not by impinging on the solid Parts of Bodies but by some other Principle, 'tis probable that these Rays which do impinge on the solid Parts of Bodies, are not reflected but *stified* and *lost* in the Bodies; for otherwise two Sorts of Reflexions must be allowed. Should all the Rays be reflexed which impinge on the Internal Parts of Water or Chrystal, these Substances would rather have a cloudy, than a transparent Colour. To make Bodies look black many of the Rays must be stopt, retained and lost in them, and it seems not probable that any Rays can be stopt and stified in them, which do not impinge on their Parts. After this he shews his Prop. 9. *That Bodies reflect and refract Light by one and the same Power variously exercised in various Circumstances*; as appears from several Considerations. 1. Because when Light goes out of Glass into Air, as obliquely as it can possibly do, if its Incidence be made still more oblique, it becomes totally reflected; for the Power of the Glass after it hath refracted the Light as obliquely as is possible, if the Incidence become still more oblique, becomes too strong to let any of its Rays go thro', and consequently cause a *Total Reflexion*. 2. Because Light is alternately reflected and transmitted by thin Plates of Glass for many Successions, according as the Thickness of the Glass increases in Arithmetical Progression; for here the Thickness of the Glass determines *whether the Power by which Glass acts upon Light*, shall cause it to be reflected, or permit it to be transmitted. And, 3. Because those Surfaces of Transparent Bodies, which have the greatest refracting Power, reflect the greatest Quantity of Light, as was shewn in the first Proposition.

And in the Latin Edition of his Opticks towards the End, under the 21st Query, he shews that the

Cause of *Reflexion* and *Refraction* both, is only the Attraction of the Part of the Body acting upon the Rays of Light at a little distance, as they pass out of, or thro' the Surface of the Glass. (See *Light*) For as the Rays pass out of Glass into a *Vacuum* they are always inflected towards the Glass; and if they fall on the *Vacuum* too obliquely, they will return again to the Glass, and be totally reflected. Now this Phenomenon can't be attributed to the Resistance of the *Vacuum*; (which is nothing) but must be attributed to some force in the Glass, which reduces or draws back the Rays after they are gotten out of the Glass into the *Vacuum*. For if the hinder Surface of the Glass be covered with clear Water, Oil, pellucid and liquid Honey, a Solution of sublimate, &c. Then the Rays which otherwise would have reflected, will pass into that Liquor. And this shews plainly that the Rays are not reflected, till after they have pass'd the hinder Surface of the Glass, or are beginning to go out of it. For if as they are going out, they fall into any of the Liquors above-mentioned, they then go on in the Course they were in before: because the Attraction of the Glass is balanced by the Attraction of the Parts of the Liquor.

And this appears yet plainer, by the Compression of two Prisms, or Object Glasses of a long Telescope, together, when one is *plain*, and the other a little *Convex*; for then they will neither exactly touch, nor yet be at any considerable distance one from another, as it may be not above the  $\frac{1}{1000000}$  part of an Inch.

For then the Rays which, at passing out of the hinder Surface of the first Glass, would have been reflected and turn again to it, if the Distance of the 2<sup>d</sup> Glass had been considerable, will now all readily in that part, pass through the Second Prism or Object Glass, just as if there was a hole thro' it. See Sir *Is. Newton*. Observ. 1. 4. and 8th. of Part 1. Book 2. of his Opticks.

It hath been discovered by that Excellent *Danish* Astronomer, Mr *Romer*: that tho' the Motion of the Rays of Light coming from us to the Sun be amazingly swift, yet it is by no means instantaneous. And the Velocity of that Motion may be thus determined in the Figure annexed; let the Circle *HLKEFG* represent the Earths annual Orbit, described by its Revolution round the Sun, which suppose placed in *A*. Let the Point *B* represent the Planet *Jupiter*, casting a Shadow backwards towards those Parts which lie behind him in respect to the Sun. Let the little Circle *DRC* denote the Orbit of any one of the Statellites of *Jupiter*, revolving around that Planet placed in *B*. And let the Chord *GF* be in length equal to the Semi-diameter of the Earth's annual Orbit *AE*, or *AH*: As let also *LK* be, on the other hand.





All this supposed, 'tis plain that those *Immersion*s of *Jupiter*'s Satellites into his Shadow, and those only which happen from their Conjunction to their Opposition with that Planet, can be visible to the Inhabitants of the Earth, which live within the Semi-circle *H G F E*: And those *Emersions* out of his Shadow, and those only which happen from the Satellites Oppositions to their Conjunction with *Jupiter* again, can be visible to such as live under the Semi-circle *H L K E*: Because the Interposition of the Body of *Jupiter*, hinders *both* from being visible. 'Tis apparent also, that an Observer placed in *F*, if the Motion of Light were instantaneous, would see the Immersion of a Satellite into the Shadow at the same Moment of absolute Time, as another would do if placed in *G*; and it would do the same thing on the other side with regard to the Points *K* and *L*.

But if the Propagation of Light take up any sensible Time, 'tis plain that the Observers posited in *G* and *L*, being nearer to *Jupiter* by an intire Semi-diameter of the *Magnus Orbis*, than those in *F*, and *K*; must needs see the Immersions and Emersions a little sooner than those can do; and from the Space of Time which is proportionable to that Semi-diameter of the Earth's Annual Orbit, may Estimation be made of the Velocity of the Rays of Light; and so the thing is in Fact: For whenever the Earth is in that part of its Orbit which is nearest to *Jupiter*, the Immersions of the *Satellites* into his Shadow do anticipate the mean Time which they should happen in, according to Calculation; as when the Earth is in the opposite Parts of the Orbit, they do really appear later than by Calculation they should do. And so they will appear later to an Observer placed in *F*, than to one placed in *G*; and the Emersions later to one in *K*, than to one in *L*: As Mr. *Romer* first found, and is now agreed on by all Astronomers. There was indeed

some doubt about this matter started by *Cassini*; but our Accurate Mr. *Halley* Savilian Professor of Geometry at *Oxford*, hath cleared up all the Difficulty; and demonstrated that this Progressive Motion of the Rays of Light, to such a Distance, and in such a given Time, is absolutely necessary to account for the *Phenomena* of the Eclipses of the Satellites of *Jupiter*. And as to the Time, or with what determinate Velocity the Rays move, Mr. *Romer* judged that it required about Eleven Minutes of an Hour, for the Light reflected from *Jupiter*, to move the length of the Chord *F G* in the Figure above; or the Distance of the Semi-diameter of the Earth's annual Orbit: But this, by *Cassini*'s more accurate Observations, seems to be much lessened, for according to him it can't be above 7 Minutes and 5 Seconds. Suppose then it be reckoned at 9 Minutes, which is the *Medium* between *Romer*'s Eleven, and *Cassini*'s Seven. Then will the Motion of Light be so prodigious swift, as to move about Eighty Millions of Miles in 9 Minutes: That is 8888888 Miles in a Minute; and 148148 Miles in a Second; and 74074 Miles in half a Second, or while you can pronounce *One, Two*, distinctly.

A Motion, tho' not instantaneous, as no one can be; yet so wonderfully swift, that the Motion of a Bullet from the Mouth of a Cannon, (or any such like Velocity of a Body projected,) is like the creeping of a Snail, the Motion of the Legs of the *Ignavus*, or the imperceptible Pace of the Hand of a Clock, when compared with it: Nay, the Motion of the Earth it self in the Annual Orbit, which yet is pretty swift, (*viz.* at the Rate of  $3\frac{1}{2}$  *English* Miles in a Second) is not the Ten Thousandth part of the Velocity of the Rays of Light.

From which very surprising Proposition, the Ingenious Mr. *Whiston* deduces these Corollaries.

1. That the Eclipses of the Sun, Moon, or Satellites of *Jupiter*, do not happen at the same moment of Time, that they appear to us to do.

2. That the more remote any Planets are from us the longer will be the Distance between the *true*, and *apparent* Time of their Eclipses: Thus, tho' the Moon's Eclipses will appear to us to be nearly at the same Time, at which they really happen; yet those of the Sun must appear later, those of the Satellites of *Jupiter*, later yet; and those of *Saturn*'s Satellites, latest of all.

3. The apparent Places of the Sun, and the Planets in the Heavens, are not their true and real ones at any Time of Observation.

4. Supposing the Distance of the fixed Stars from us to be so immensely great, as we have all the reason in the World to conclude it to be; and to which the Distance of the Sun from us hardly bears any sensible Proportion; 'tis plain that the Light of the fixed Stars cannot come to us in many Hours, nor in many Days nor Weeks; perhaps, not in some Months Time. So that, as that Excellent Mathematician the Honourable Mr. *Francis Roberts*, was once in Discourse suggesting to me; if the Author of Nature should please to annihilate *Syrius*, or any other fixed Star; it might be 3 Months Time before we should miss him, and find his Place vacant in the Heavens.



RAY Principal, in Perspective, is the perpendicular Distance between the Eye and the Vertical Plane, or Table, as the *French* call it.

RAY of Reflection is the right Line whereby the Reflection is made.

RAY of Refraction, or broken Ray, is a right Line whereby the Ray of Incidence changeth its rectitude, or is broken in traversing the Second Medium, whether it be thicker or thinner.

RAYS, or Beams of the Sun, or Rays of Light, are either according to the Atomical Hypothesis, those very minute Particles or Corpuscles of Matter, which continually issuing out of the Sun, do thrust on one another all around in Physically short Lines; (and that this is the right Opinion, many Experiments do evince, particularly the Incomparable Sir *Is. Newton* about Light and Colours) or else as the *Cartesians* assert, they are made by the Action of the Luminary on the Contiguous Æther and Air, and so are propagated every way in straight Lines, through the Pores of the Medium.

RAYS Convergent, are those which going from divers Points of the Object, incline towards one and the same Point tending to the Eye.

RAYS Divergent, are those which going from a Point of the visible Object, are dispersed, and continually depart one from another, according as they are removed from the Object.

RAYS Parallel, are those that keep an equal Distance from the visible Object to the Eye, which is supposed to be infinitely remote from the Object.

RAZANT Line of Defence. See *Rasant Line of Defence*.

REACH, is the Distance between any two Points of Land, that lie in a right Line one from another.

REACTION: See *Repulse*.

REACTION; The Naturalists say, that Reaction is directly contrary and equal to Action, in Bodies. Or the mutual Actions of two Bodies striking one against another are exactly equal, but made with contrary Directions. Or yet in other words by the Action and Reaction of Bodies one on another, there are produced equal Changes in each; and those Changes are *impressed* towards (directly) *contrary Parts, or ways*. This will be best understood by Instances: For, whatever Body presses or draws another, is equally pressed or drawn by it again. If any one press a Stone with his Finger, his Finger is as much pressed by the Stone: If a Horse by a Rope, &c. draw a Stone, the Horse shall equally be drawn by the Stone; for the Rope being stretched both ways, endeavours to relax it self again, and by that means will draw the Horse towards the Stone; and will as much hinder the Progression of the Horse, as it forwards the Procession of the Stone. If any Body lighting against another doth by its force any way change its Motion; it self will undergo the same Change in its own proper Motion, but towards contrary Parts, from the Reaction of that Body, and the Equality of its mutual Pressure. By these Actions are produced equal Changes, not indeed of the *Velocities*, but of the *Motions* of Bodies; (*i. e.* in such Bodies as have no Impediment any other way) for the Changes of their Velocities, being made towards contrary Parts, (because the Motions are equally changed) are reciprocally proportional to the Bodies themselves.

REAFFORESTED is used, where a Forest hath been *Disafforested*, and then made a Forest again: As the Forest of *Dean*, by 20 *Car*, 2.

REALGAL, or *Sandaracha*, is red Arsenick.

REAL Horizon. See *Horizon*.

REAP-Towel, or *Rip-Towel*, was formerly a Gratuity or Reward given to Customary Tenants, when they had reaped their Lord's Corn.

REAR-Half-Files, are the 3 hindermost Ranks of a Battalion when it is drawn up 6 deep.

REAR-Line of an Army encamped; is the second Line: this lies about 400 or 500 Yards distant from the first Line, which is called the *Front-Line*. Sometimes there is a Third, which is called the *Reserve-Line*.

REAR-Rank, is the last Rank of a Battalion when drawn up.

REASON, a Faculty or Power of the Soul, whereby it distinguishes good from evil, and truth from falsehood, or it is properly defin'd that principle whereby comparing several Ideas together, we draw Consequences from the Relations which they are found to have; Mr. *Lock* observes that *Reason* comprehends two distinct Faculties of the mind, *viz.* *Sagacity*, whereby it finds intermediate Ideas; and *Illation*, whereby it so orders and disposes of them, as to discover what connection there is in each Link of the Chain, whereby the extreams are held together, and thereby as it were draws into View, the truth sought for.

REASON, in Mathematicks, the same with Proportion; 'tis better called by the *Latin* Name *Ratio* (which see) to avoid confounding it with the common Signification of the word *Reason*.

REASON [in *Logick*] a necessary or probable Argument, or an Answer to the Question. Why is it?

REASON [in *Metaphysics*] is used in the same Sense as Essence, or that whereby any thing is what it is.

REASON or *Reson*, and, as some seem to write it more truly, *Raising Pieces*, are those Pieces of Timber which lie under the Beams on the Brick or Timber in the Side of a House.

REASONABLE-Aid, was a Duty claimed by the Lord of a Fee of his Tenants, holding in Soccage or Knights Service to marry his Daughter, or to make his Son a Knight.

REATTACHMENT, is a Second *Attachment* of him that was formerly attached and dismissed the Court without Day, as by the not coming of the Justices, or some such Casualty. And is said to be either General or Special. General-Reattachment, is where a Man is reattached for his Appearance upon all Writs of Assize lying against him: Special-Reattachment, must be for one or more certain.

REBATE, is a Difference between a certain Quantity of Money, due at a certain Day, and the present Value or Worth of it; or in other words, how much *less* a Man ought to pay, who pays at the present, a Summ of Money not due till a certain Number of Years, &c. are expired. On this see an Act both from Equity and a Mathematical *Calculus* in the *Acta Eruditorum Lipsiæ*, from October, 1683. by G. G. *Leibnitz*.

REBATEMENT [in *Heraldry*] a diminution, or an abatement of the Dignity of the Figures or Bearings in a Coat of Arms.

REBELLIOUS Assembly, is a gathering together of Twelve or more Persons, intending or going



going about, practising or putting in Ure unlawfully, and of their own Authority, to change any Laws, Statutes, &c. to destroy Enclosures, break down Banks of Fish Ponds, &c. unlawfully to get common; to destroy Deer in Parks, Conies in Warrens, Doves in Dove-Houses, Fish in Ponds, to burn Stacks of Corn, or to abate Rents or Prizes of Victuals, &c. See *Ch. 1. Mar. 12. and 1. Eliz. 17.*

REBELLUM in some of our old Charters signifies the same as a Rejoinder, Replication, or Answer in a Court of Equity.

REUSSSES, are in *Heraldry* such Coats of Arms as bear an Allusion to the Surname of the Person, as; Conies for *Conisby*, 3 Cups for *Butler*, 3 Castles for *Castleton*: And such Bearings are very ancient.

REBUTTER, in common-Law, when a Man grants Land to the use of himself, and the Issue of his Body, to another in Fee with Warranty: And the Donee leaseth out his Lands to a Third for Years; the Heir of the Donor impleadeth, the Tenant alledging, That the Land was in Tail to him: The Donee comes in, and by virtue of the Warranty made by the Donor, repelleth the Heir, because tho' the Land was Entailed to him, yet he is Heir to the Warrantor likewise; and this is called a *Rebutter*. And if I grant to my Tenant, to hold *Sine impetitione vasti*, and afterwards implead him for Waste made; he may debar me of this Action, by shewing my Grant; and this is also a *Rebutter*.

RECAPTION, is a Second Distress of one formerly distrained for the same Cause, and also during the Plea grounded on the former Distress: It likewise signifies a Writ lying for the Party thus Distrained.

RECEIVER is commonly used in the Civil Law in an ill Sense, for one that receives stolen Goods, and conceals them; but when annexed to other Words, 'tis used in a very good one; as the

RECEIVER of the *Fines*, which is an Officer that receives the Money of all such as compound with the Crown upon an Original Writ in the Court of Chancery. There is also the

RECEIVER General of the *Dutchy of Lancaster*, which gathers in all Fines, Forfeitures, Assessments, &c. within that Dutchy.

RECEIVER. See *Recipient*.

RECEPTACLE of the *Chyle*, was known and described by *Bartholomæus Eustachius* many Years before the Discovery of the Lacteal Veins, *vid. Keil's Anatom. p. 47, 48.* In living Bodies this Receptacle is easily found, but with greater difficulty in such as are dead. It lies about the descending Trunk of the great Artery, between the *Celiac* and *Emulgent* Arteries, surrounded by several Lymphatick Glands, which are called *Glandule Lumbares*, which discharge their *Lympha* into it. It appears to be only a large Bag formed by the Union of the second Order of Lacteals, and many Lymphæducts which open into it; it will contain about an Ounce of Water. Sometimes in Brutes as well as in Men, it is divided into two or three Parts, which at last unite into one Duct about the Bigness of a Goose-quill.

RECEPTACULUM *Chyli*, was first found out by *Pecquet, A. D. 1651*, 'tis a Cavity into which all the Lacteal Veins empty themselves: it is of a Vesicular Substance, which is thicker in Men than

in Beasts, but the Cavity is larger in Beasts than Men: Out of it goes the *Ductus Thoracicus*; which see.

RECESSION of the *Equinoxes*, is the going back of the Equinoctial Points every Year about 50 Seconds. The Reason of which is, That the Axis of the Earth, after many Annular Revolutions round the Sun, really deviates from that Parallelism, which it seems to keep with it self all the time of one Annular Revolution: By this Aberration it describes a Conical Superficies; and the Earth's Equator moving round the Sun, together with the Earth's Axis, the Intersections of the Celestial Equator with the Ecliptick, will run back, or move in *Antecedentia*, as will all other Points of the Ecliptick, (as well as those Equinoctial ones.) And therefore the Signs or Fix'd Stars that make the 12 Zodiacal Constellations, will appear to move forward, or in *Consequentia*; as they now seem to have done by the Quantity of a whole Sign; for which Reason, you find the Picture of the *Ram* painted on our Globes at the beginning of the Sign *Taurus*, &c.

Dr. Gregory in his Excellent *Astronomia Physica & Geometrica*, Prop. LXIV. Lib. 1. makes the Prolate Spheroidical Figure of the Earth, to be the Primary Occasion of this Recession of the Equinoctial Point; and withal shews that the Earth's Axis in every Annual Revolution round the Sun, twice changes its Inclination to the Ecliptick, and as often returns again to its former Position.

RECHANGE, or *Re-exchange*, in Commerce, a second Payment of the Price of Exchange; or rather the Price of a New Exchange, due upon a Bill of Exchange that comes to be protested; and to be refunded the Bearer, by the Drawer, to the Endorser.

The Occasion of Rechange is, when the Bearer of a Bill of Exchange, after protesting it for want either of Acceptance, or of Payment, borrows Money on his own Promise, Bond, or the like; or draws a Bill of Exchange in the Place where the Payment was to be made, on the Person who furnished the first; for which he pays a second Exchange, which being added to the first already paid, the Drawer of the first Bill makes two Exchanges, properly call'd *Exchange* and *Re-exchange*.

The Bearer of a protested Bill, has a right to recover both the one and the other on the Drawer, yet the simple Protestation the Bearer makes in the act of Protest, that he will take up a like Sum at Re-exchange, for want of his Bill being accepted or paid; is not sufficient to entitle him to demand the Reimbursement of his Rechange, unless he make it appear he has actually taken up Money in the Place whereon the Bill was drawn.

Otherwise the Rechange will only amount to the Restitution of the first Exchange, with Interest, the Expences of protesting, and of the Journey, if there have been any.

If a Bill of Exchange, payable to the Bearer, or Order; come to be protested, the Rechange is only due upon the Drawer for the Place where the Remittance was made; not for those Places where it may have been negotiated; at least, the Drawer has a Right to be refunded his Rechange for those Places, by the Endorser.

Indeed the Rechange is due from the Drawer, upon all Places where a Power of Negotiating is given by the Bill, and upon all others, if the Power



Power of Negotiating be Indefinite, *Lastly*, The Interest of the Rechange, of the Expences of the Protest, and the Journey, are only due from the Day of the Demand.

'Tis supposed to be the *Gibelins* driven out of *Italy* by the *Guelfs*; and shelter'd at *Amsterdam*, who first established the Custom of Rechange, on pretence of the Interests, Damages, and Expences they underwent, when the Bills given them for the Effects they had been obliged to abandon, were not accepted, but came to be protested.

RECIDIVUS *Morbus*, a Relapse, is when the Morbifick Matter, that was left in the first Distemper, begins to work and ferment again.

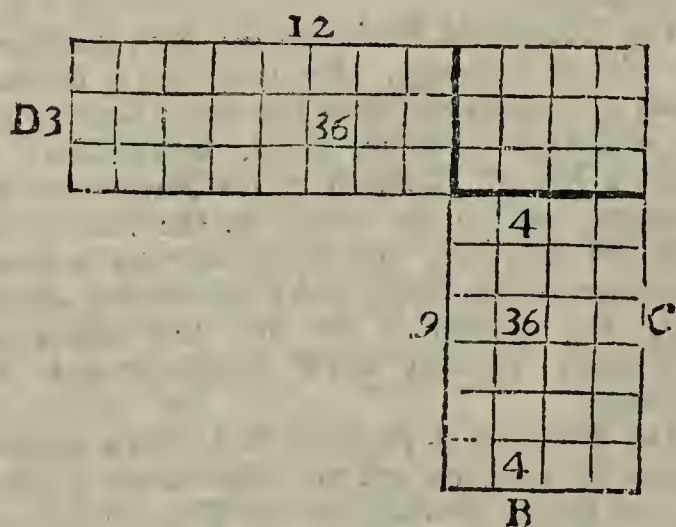
RECIPIANGLE, a Mathematical Instrument, which is used to take the Quantity of Angles, especially in making the Plans of Fortifications. A *Recipient Angle*.

RECIPIENTS, or *Receivers*, are those Vessels, which in Distillation, are Luted to the Beak, or Nose of an Alembick, Retort, &c. to receive the Matter which is raised or forced over the Helm by the Fire. That Glass also which is exhausted of Air by Mr. *Boyle's* Air-Pump, and within which any Animal or other Bodies, are included to make Experiments upon, is by him usually called the *Receiver*.

RECIPROCAL *Figures* in Geometry, are such as have the Antecedents and Consequents of the Ratio in both Figures.

Here  $A : B :: C : D$ ,  
i. e.  $12 : 4 :: 9 : 3$ .

A



That is, as much longer as the Side A in the first Rectangle is than B :: so much deeper is the Side C in the second Rectangle, than the Side D in the first; and consequently the Length of one is compensated by the Depth of the other; and also as the Side A is  $\frac{3}{4}$  longer than the Side C, so the Side B is one 4th longer than D. Wherefore the Rectangles must needs be equal.

And this is the Foundation of the *Catholic Theorem*; That the Rectangle of the Extremes must always be equal to that of the Means: And consequently the Reason of the *Rule of Three*, or *Golden Rule*; for suppose there was given any three Numbers or Quantities Geometrically proportional, as A, B, and C, and that it were required to find a fourth D proportional to them.

Since it is that  $A : B :: C : D$  therefore  $A D = B C$ , and consequently  $D = \frac{B C}{A}$ ; that is, the

Fourth Term is equal to the Quotient of the Second, multiplied by the Third Term, divided by the First:

Or thus in Numbers.

Suppose given 12, 4, and 9; required a fourth Proportional.

Now as  $12 : 4 :: 9 : Q$ .

But  $12 Q = 4 \times 9 = 36$ .

Therefore  $Q = \frac{4 \times 9}{12}$  ( : 3. by dividing both

Sides by 12.

C O R O L L A R Y.

And from hence 'tis plain, That if any two Triangles, Parallelograms, Prisms, Parallelopipeds, Pyramids, Cones, or Cylinders, have their Bases and Altitudes *Reciprocally proportional*, those two Figures or Solids are equal to one another; and *vice versa*, if they are equal, their Bases and Altitudes are Reciprocally proportionable.

RECIPROCAL *Proportion*, is when in four Numbers, the Fourth is lesser than the Second, by so much as the Third is greater than the First, and *vice versa*; on which is founded the Inverse or Indirect *Rule of Three*, thus.

$4 : 10 :: 8 : 5$ .

See the *Corollary* after Reciprocal Figures.

There is great use made of this *Reciprocal Proportion*, by Sir *Isaac Newton*, and others, in their Demonstrations of the *Laws of Motion*, &c. and indeed without a clear Knowledge of it, they cannot be understood.

RECKONING [in *Navigation*] the Estimation of the Quantity of the Ship; or of the run of a Ship between one place and another.

RECLINATION of a *Plane*, is the Quantity of Degrees which any Plane, on which a Dial is supposed to be drawn, lies or falls backwards from the truly upright or vertical Plane.

RECLINATION of a *Plane*, is the Number of Degrees which any Dial Plane lies or falls backward from the Zenith. This is found easily by the means of long Rules, and a Quadrant; for having drawn an Horizontal Line on the Plane, by a Level or Quadrant, and to it another Line at Right-angles, to which apply a Ruler so, that one End of it may hang over or reach beyond the Plane: Then will a Quadrant applied to the under Edge of that Ruler, shew you the Degrees and Minutes of the Plane's Reclination; accounting from that Side of the Quadrant that is contiguous to the Edge of the Ruler.

RECLINING, in Dyalling, the Plane that leans from you when you stand before it, is said to be a *Reclining Plane*.

RECLINING *Declining Dyals*. See *Declining Reclining Dyals*.

RECLUSE, is one that by reason of his or her Order in Religion is shut up, and cannot stir out of a Cloyster, &c. See *Littleton*, Sect. 434.



RECOGNITIO, is the Impannel of a Jury, or the Inquest of 12 or more legal Men, who were therefore called *Recognitores*. So *habere Recognitionem*, was to have a Trial or Verdict of Jurors; for Liberty of which a Fine was formerly paid to the King. *Recognitio Novæ Affisæ*, is a new Trial.

RECOGNIZANCE, [in *Law*,] is a Bond or Obligation of Record, testifying the *Recognisor* to owe to the *Recognisee* a certain Sum of Money, and is acknowledged in some *Court of Record*, or before some Judge, Master of the Chancery, or Justice of Peace; and those that be meer *Recognizances*, are not Sealed, but Enrolled, and Execution by force thereof, is of all the *Recognisor's* Goods or Chattels, (except Draught Beasts and Implements of Husbandry) and the Moiety of his Lands.

RECOGNISEE, is he to whom one is bound in a *Recognisance*.

RECOGNITIONE, *adnullanda per vim & duriem facta*, is a Writ to the Justices of the Common Bench, for the sending of a Record touching a *Recognisance*, which the *Recognisor* suggests to have been acknowledged by Force and Dureffe, that if it be so, it may be annulled.

RECOGNITORS, is a Word often used for the Jury impanelled upon an Affize: The reason why they are so called, is, because they acknowledge a Disseisin by their Verdict.

RECOLLECTION, is a Mode of Thinking, whereby those Ideas sought after by the Mind, are with Pain and Endeavour found, and brought again to View.

RECONNOITRE, [in the *Military Art*,] is to view and examine the State of Things in, or to make a Report thereof.

RECORD, [in *Law*] signifies an authentick and uncontrollable Testimony in Writing, contained in Rolls of Parchment, and preserved in Courts of Record; and they are said to be *vetustatis & veritatis vestigia*. An Act committed to Writing in any of the King's Courts, during the Term wherein it is written, is alterable, being no *Record*; but that Term once ended, and the Act enrolled, it is a *Record*, and of that Credit, that admits no Alteration or Proof to the contrary. Lawyers reckon three Sorts of Records, *viz.* *Record Judicial*, as Attainder, &c. *Record Ministerial* upon Oath, as an Office or Inquisition found. And a *Record* made by Conveyance and Consent, as a Fine or Deed enrolled, or the like.

RECORDARE *Facias*, or *Recordari Facias*, is a Writ directed to the Sheriff, to remove a Cause depending in an Inferior Court, as Court of ancient Demesne, Hundred or County, to the King's-Bench, or Common-Pleas; it seems to be called *Recordare*, because it commands the Sheriff to make a Record of the Proceedings by himself and others, and then to send up the Cause.

RECORDER, is he whom the Mayor, or other Magistrate of any City, or Town Corporate having Jurisdiction, or a Court of Record within their Precincts, by the King's Grants, doth associate unto him for his better Direction in Matters of Justice and Proceedings according to Law; and is therefore for the most part a Man versed and experienced in the Law.

RECORDO & *Processu Mittendis*, is a Writ to call a Record together, with the whole Proceeding in the Cause out of an Inferior Court into the King's-Bench Court.

RECORDO *Utlagariæ Mittendo*, is a Judicial Writ: Which see in *Reg. Judic. fol. 32*.

RECOVERY, in a Legal Sense, signifies an obtaining any Thing by Judgment or Trial at Law, as *Eviçtio* doth among the *Civilians*.

And there is a *True* and a *Feigned Recovery*: A *True Recovery* is an actual or real Recovery of any Thing, or the Value thereof, by Judgment; as if a Man sue for any Land, or other Thing, moveable or immoveable, and have a Verdict and Judgment for him.

A *Feigned Recovery*, is, (as the *Civilians* call it) *Quædam Fictio Juris*, a certain Form or Course set down by Law, to be observed, for the better assuring of Lands and Tenements unto us; and the End and Effect thereof is to discontinue and destroy Estates Tail, Remainders and Reversions, and to bar the Intails thereof.

And in this Formality are required three Persons, *viz.* The *Demandant*, *Tenant*, and *Vouchee*.

The *Demandant*, is he that brings the Writ of Entry, and may be termed the *Recoverer*.

The *Tenant*, is he against whom the Writ is brought, and may be termed the *Recoveree*.

The *Vouchee*, is he whom the Tenant voucheth, and calls to Warranty for the Land in demand.

A *Recovery with double Voucher*, is, where the Tenant voucheth one, who voucheth another, or the common Vouchee.

And a *Recovery with treble Vouchers*, is where three are vouched: As when a Man that is desirous to cut off an Estate Tail in Lands or Tenements, to the End, to sell, give, or bequeath it, causes a Feigned Writ of Entry, *Sur disseisin en le post*, to be brought for the Lands of which he intends to cut off the Entail, and in a Feigned Count, or Declaration thereupon made, pretends he was disseised by him, who by a Feigned Fine or Deed of Bargain and Sale, is named, and supposed to be, the Tenant of the Land. This Feigned Tenant, if it be a *Single Recovery*, is made to appear and vouch the *Bag-bearer of Writs* for the *Custos Brevium*, in the Common-Pleas, (for there only can such Recoveries be suffered) who makes Default. Whereupon the Land is recovered by him that brought the Writ, and a Judgment is by such Fiction of Law entred, that the Demandant shall recover the



Value of the Lands against the Lands of the *Vouchee*.

*Bag-bearer*, is a poor unlanded and illiterate Person, which is feigned to be a Satisfaction to the Heir in Tail, tho' he is never to have or expect it.

This *Feigned Recovery*, is also called a *Common Recovery*, because it is a beaten and common Path to that End for which it is appointed, viz. to cut off the Estates above specified. But a *True Recovery* is as well of the Value as of the Thing: As if a Man buy Land of another with Warranty, which Land a third Person afterwards by Suit of Law recovereth against me, I have my Remedy against him that sold it me, to recover in Value; that is, to recover so much in Money, as the Land is worth; or so much other Land by way of Exchange.

RECOUPE, [in *Law*,] is a quick and sharp Reply to a peremptory Demand, and used by Lawyers to defalk or discount; as if a Man hath Ten Pounds issuing out of certain Lands, and he disseises the Tenant of the Land in an Assise brought by the Disseisee, the Disseisor shall *Recoupe* the Rent in the Damages.

RECREANT, [in *Old Law Books*,] signifies cowardly, faint-hearted.

RECREMENT, any Superfluous Matter in the Blood or Body, or any of its Parts.

RECREMENTS, a Word used by the Physicians and Anatomists, for such Juices as are separated in the several Glands of the Body for proper and peculiar Uses; as the Spirits, the Lympha, the Gall, the Pancreatick Juice, the proper Ferments of the Stomach, Guts, &c. and these are distinguish'd from Excrements, which are expelled out of the Body, as being of no further Use to it.

RECRIMINATION, a Posterior Accusation, brought by the Accused against the Accuser. *L.*

RECRUDESCENCE, [in *Medicine*,] is when a Disease that is gone off returns again.

RECTA *Directrix*, is a Line in Conicks made by the mutual Interfection of the Vertical Plane, with the Plane of the Base. *De la Hire*.

RECTA *Prisa Regis*, was formerly a Right the King claimed of taking out of every Ship laden with Wines, One Butt or Pipe, before the Mast, and Another behind it as a Custom or Duty due to the Crown. *K. Edward 1.* in his Charter of Privileges to the Barons of the Cinque Ports, among other Things, discharges them particularly from this Duty.

RECTANGLE, [in *Arithmetick*,] is the same with Product: Which see.

RECTANGLES, [in *Geometry*] are Parallelograms, whose Sides are unequal, but Angles right. Their Area is found by multi-

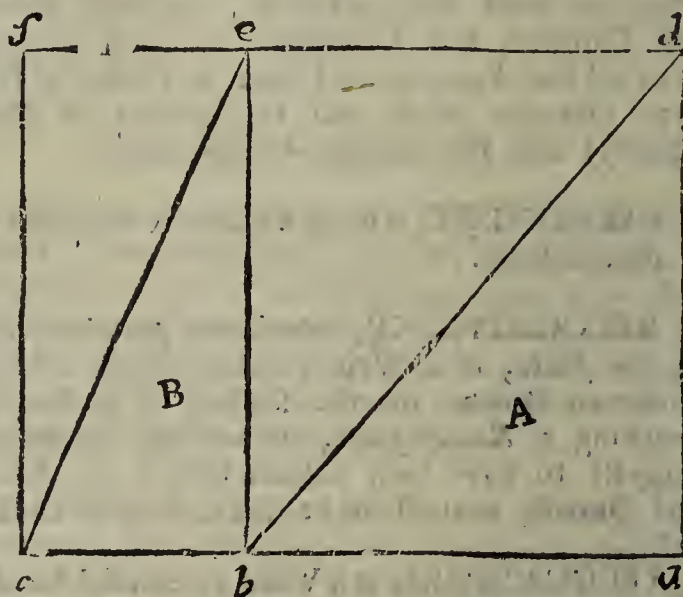
plying the two unequal Sides one into another for then the Product is the Superficial Content or Area.

RECTANGLED Triangle, the same with Right-angled Triangle.

All Rectangles, (as A and B) which have the same Height, are to one another as their Bases.

That is,

$$\square A : \square B :: ab : bc.$$



For A is made by the Multiplication of *ba* its Base by the Line *be*; and B is also made by multiplying *cb* its Base by the same Line *be* (or its equal *cf*.)

But the Product of any two Numbers Multiplied by the same Third Number, as those Numbers were to each other before Multiplication. Therefore,

$$A : B :: ab : bc. \text{ Q. E. D.}$$

Hence all Rectangles, or Parallelograms, between the same Parallel Lines, or which have the same Height, must be to one another as their Bases are.

For they are all equal to Rectangles, on the same or equal Bases with themselves, and consequently must have the same Proportion to each other, as such Rectangles; that is, be to each other as their Bases *Q. E. D.*

And the same Thing must be true of all Triangles that are between the same Parallels, or which have the same Height, because they are the halves of those Parallelograms. See the Figure.

RECTANGULAR, or Right-angled, is spoken of a Plain Figure in Geometry, when one or more of its Angles are right. Of Solids, 'tis spoken in respect of their Situation: For if their Axes be perpendicular to the Plane of the Horizon, they are therefore Rectangular, or Right Cones, Cylinders, &c.

RECTANGULAR Section of a Cone; by this the Ancient Geometers always meant a *Parabola*, which Conick Section, before *Apollonius*, was only considered in a Cone, whose Section by the Axe would be a Triangle, Right-angled at the Vertex. And hence it was that *Archimedes* entituled his Book



Book of the *Quadrature of the Parabola*, (as 'tis now called) by the Name of *Rectanguli Coni Sectio*.

RECTATIO, was a word formerly used for a *Claim of Right*; or an Appeal to the Law for the recovery of such a claimed Right. So also the Word,

RECTITUDO, was then used for a *Right* or *Legal Due*; and Oblations and Tithes were called *Rectitudines Dei*.

To RECTIFIE, or *Rectification*, [in *Chymistry*,] is the Distilling over again of any Spirit, in order to a more fine and pure State and to separate from it any Heterogeneous Parts, that might rise with it before.

RECTIFIE is a Word used in the Description and Use of Globe, or Sphere. For the first Thing to be done before any Problems can be wrought on the Globe, is to *Rectify it*: that is, To bring the Sun's Place in the Ecliptick on the Globe, to the graduated Side of the Brass Meridian, to elevate the Pole above the Horizon, as much as is the Latitude of the Place, and to fit the Hour Index exactly to Twelve at Noon, screwing also the Quadrant of Altitude, (if there be occasion) to the Zenith. All this is comprehended under the Word *Rectify the Globe*: And when this is done, the (Celestial) Globe represents the true Posture of the Heavens, for the Noon of that Day it is rectified for.

RECTIFIER [in *Navigation*] is an Instrument consisting of two Parts, which are two Circles either laid one upon, or let into the other, and so fastned together in their Centers, that they represent two Compasses, one fixed, the other moveable; each of them divided into the 32 Points of the Compass, and 360 Degrees, and numbred both Ways, both from the North and the South, ending at the East and West, in 90 Degrees.

The Fixed Compass, represents the Horizon, in which the North, and all the other Points of the Compass are fixed and immoveable.

The moveable Compass represents the Mariners Compass, in which the North, and all the other Points are liable to Variation.

In the Centre of the moveable Compass is fastned a Silk Thread, long enough to reach the out-side of the Fixed Compass. But if the Instrument be made of Wood, there is an Index instead of the Thread.

Its Use is to find the Variation of the Compass, to rectify the Course at Sea; having the Amplitude or Azimuth given.

RECTIFYING of Curves, [in *Mathematicks*] is to find a strait Line, equal to a curved one; or a Plane equal to a curved Surface.

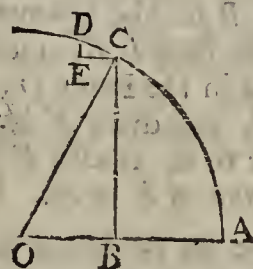
Of this Dr. Wallis gave the first Hint to the World, in his *Arithmetick of Infinites*, Prop. 38. & *Scholium*.

Soon after which, Mr. William Neil applied those Considerations to the *Semi-cubical Paraboloid*, where the Cubes of the Ordinates are as the Squares of the Diameters: And shewed that there the small Segments of the Curve, cut by the Ordinates at equal Distances, are as the

Ordinates in a Parabola, and therefore their Squares increased by Equals, in Arithmetical Progression: Wherefore that Curve must be to a Right Line :: as the Trunk of a Parabola, to the Parabola: Which, the Quadrature of the Parabola being known, is a known Proportion; and this was the first Attempt of this Nature. But it was afterwards soon demonstrated also by Sir Christopher Wren, my Lord Brouncker, and by Dr. Wallis. And the Year following, viz. 1658. Sir Christopher Wren shewed the Curve of the Cycloid, to be Quadruple of its Axis: Which was the second Demonstration of a strait Line equal to a crooked one. Of which see Dr. Wallis's *English Algebra*, p. 292, &c. See more also in his *Excellent Book De Cycloide*.

RECTIFICATION of Curves. To what hath been said on this Point under *Rectifying*, and under *Cycloid*, 'twill be proper to add, what the Ingenious Mr. Moivre advances in his illustrious Specimens of the Use and Advantages of the Doctrine of Fluxions: Where he saith, that the *Rectification of Curve Lines* will be obtain'd, if we consider the Fluxion of the Curve as a Hypothenuse of a Rectangular Triangle, whose Sides are the Fluxions of the Ordinate and Abscisse. But in the Expression of this Hypothenuse, Care must be taken, that only one of the Fluxions be remaining, as also only one of the indeterminate Quantities, viz. that whose Fluxion is retain'd. Some Examples will render this clear.

The right Sine  $CB$  being given, to find the Arch  $AC$ . Let  $AB = x$ ,  $CB = y$ ,  $OA = r$ .



$CE$  the Fluxion of the Abscisse,  $ED$  the Fluxion of the Ordinate,  $CD$  the Fluxion of the Arch  $CA$ . From the Property of the Circle  $2rx - xx = yy$ , whence  $2r\dot{x} - 2x\dot{x} = 2y\dot{y}$ , and therefore  $\dot{x} = y\dot{y}$ . But  $CD^2 = \dot{y}^2 + x\dot{x} = \dot{y}^2 +$

$$\frac{y^2 \ddot{y}}{rr - 2rx + xx} = \frac{\dot{y}^2}{r} + \frac{y^2 \dot{y} \dot{y}}{rr - yy} = \frac{r \dot{y} \dot{y}}{rr - yy}$$

therefore  $CD = \frac{r \dot{y}}{\sqrt{rr - yy}} = \frac{1}{\sqrt{rr - yy}} \times r \dot{y}$

$$= r \dot{y} \times \frac{1}{\sqrt{rr - yy}}^{\frac{1}{2}}$$

if  $rr - yy$  be thrown into an infinite Series, and the several Members of it be multiplied into  $r \dot{y}$ , and then the flowing Quantity of each be taken, we shall have the Length of the Arch  $AC$ . After the same manner, giving the versed Sine, the same Arch may be found. For resumming the Equation found above  $2r\dot{x} - 2x\dot{x} = 2y\dot{y}$ , we have  $y =$



$\frac{r \dot{x} - x \dot{x}}{yy}$ , but  $CD^q = \dot{x}\dot{x} + \dot{y}\dot{y} = \dot{x}\dot{x} +$

$$\frac{rr\dot{x}\dot{x} - 2rx\dot{x}\dot{x} + x^2\dot{x}\dot{x}}{yy} = \dot{x}\dot{x} +$$

$$\frac{rr\dot{x}\dot{x} - 2rx\dot{x}\dot{x} + x^2\dot{x}\dot{x}}{2rx - xx}, \text{ that is, (reducing}$$

all to the same Denominator, and expunging contradictory Terms)  $\frac{rr\dot{x}\dot{x}}{2rx - xx}$ , whence  $CD$

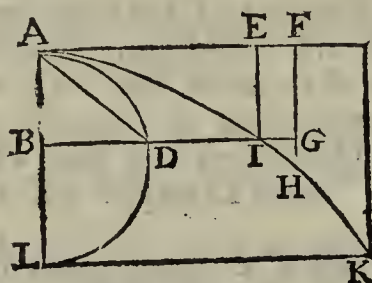
$$= \frac{r\dot{x}}{\sqrt{2rx - xx}}, \text{ and consequently the Length}$$

of the Arch  $AC$  may be easily found from what is said already.

The Fluxion of the Curve Line is sometimes more easily found, by comparing the two similar Triangles  $CED$ ,  $CBO$ , for this Proportion arises,  $CB:CO::CD$ , that is for the Circle  $\sqrt{2rx - xx}$

$$:r::\dot{x}:\frac{r\dot{x}}{\sqrt{2rx - xx}}.$$

The Curve of the Cycloid may be determin'd by the same Method too. Let  $ALK$  be a Semi-



Cycloid, whose generating Circle is  $ADL$ . Having any Point as  $B$  in the Diameter  $AL$ , draw  $BI$  parallel to the Base  $LK$ , meeting the Periphery of the Circle in the Point  $D$ ; compleat the Rectangle  $AEIB$ , and draw  $FH$  parallel to  $EI$ , and infinitely near to it, as also  $BI$  cutting  $FH$  in  $G$ , and the Curve  $AK$  in  $H$ . Put  $AL = d$ ,

$AB (= EI) = x$ ,  $GH = \dot{x}$ . It is known that the right Line  $BG$  is every where equal to the Sum of the Arch  $AD$ , and the right Sine  $BD$ : Whence 'tis manifest, that the Fluxion  $IG$  is also the Aggregate of the Fluxions of the Arch  $AD$  and the right Sine  $BD$ . But the Fluxion of the Arch  $AD$  was found =  $\frac{\frac{1}{2}d\dot{x}}{\sqrt{dx - xx}}$  and the Fluxion of the right Sine

$BD$  will be found to be  $\frac{d\dot{x} - 2x\dot{x}}{2\sqrt{dx - xx}}$ ; therefore

$$IG = \frac{d\dot{x} - x\dot{x}}{\sqrt{dx - xx}}, \text{ and therefore } IH^q (= IG^q +$$

$$GH^q) = \frac{d\dot{x}\dot{x} - dx\dot{x}\dot{x}}{dx - xx}; \text{ from whence } IH =$$

$$\frac{\dot{x}\sqrt{dd} - d\dot{x}}{\sqrt{dx - xx}} = \frac{\dot{x}\sqrt{d}}{\sqrt{x}} = d\dot{x}^{\frac{1}{2}} - \dot{x}^{\frac{1}{2}}, \text{ and conse-}$$

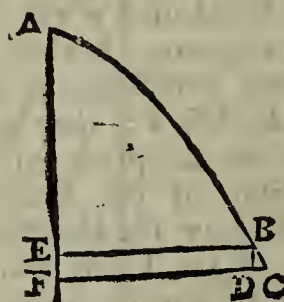
quently  $AI = 2d\dot{x} = 2\sqrt{dx} = 2AD$ . This Conclusion may also be very easily deduc'd from the known Property of the Tangent. For since the little Part of it, as  $IH$ , is always parallel to the Chord  $AD$ , the Triangles  $IGH$ ,  $ABD$  are similar,

whence  $AB:AD::GH:IH$ , that is,  $x:\sqrt{dx}::\dot{x}:\frac{\dot{x}\sqrt{dx}}{x}$ , therefore  $IH = \frac{\dot{x}\sqrt{dx}}{x} = d\dot{x}^{\frac{1}{2}} - \dot{x}^{\frac{1}{2}}$ .

By the help of the Fluxion  $IH$  also, we may investigate the Area of the Cycloid. The Fluxion of the Area  $AEI$ , is the Rectangle  $EIG = \frac{dx\dot{x} - x^2\dot{x}}{\sqrt{dx - xx}}$

$\dot{x}\sqrt{dx} - x\dot{x}$ . But the Fluxion of the Portion  $ABD$  is the same; therefore the Area  $AEI$ , and the correspondent Portion (of the Circle)  $ABD$ , are always equal.

Let  $AB$  be the Curve of the Parabola, whose Axis is  $AF$ , Parameter  $a$ ; let  $AE = x$ ,  $EB$



$= y$ ,  $AB = z$ ,  $BD = \dot{x}$ ,  $DC = \dot{y}$ ,  $BC = \dot{z}$ . The Equation expressing the Nature of the Parabola, being  $ax = yy$ , we have  $a\dot{x} = 2y\dot{y}$ , whence  $\dot{x} = \frac{2y\dot{y}}{a}$ ; but  $BC^q = BD^q + DC^q$ , that is,  $\dot{z}\dot{z} = \dot{x}\dot{x} + \dot{y}\dot{y} = \frac{4y^2\dot{y}\dot{y}}{a^2} + \dot{y}\dot{y} =$

$\frac{4y^2\dot{y}\dot{y} + a\dot{y}\dot{y}}{a^2}$ , and therefore  $z = y\sqrt{\frac{4y^2 + a^2}{a^2}}$ . If now by this Expression  $y\sqrt{\frac{4y^2 + a^2}{a^2}}$  be thrown into an infinite Series, the

Curve  $AB$  will easily be known. It appears farther, that giving an *Hyperbolical Space*, this Curve is also given, and *vice versa*. For  $\frac{1}{2}a\dot{z} = y\sqrt{y^2 + \frac{1}{4}a^2}$ , and consequently  $\frac{1}{2}az$  is the Space whose Fluxion is  $y\sqrt{y^2 + \frac{1}{4}a^2}$ . But such a Space is no other than the Exterior (Equilateral) Hyperbola  $ABEG$ , whose Semi-Axis  $AB = \frac{1}{2}a$ , its Abscisse  $AE = y$ , and its Ordinate  $EG = x$ .

For the Mensuration of a Surface described by the Conversion of a Curve round its Axis; we are to assume for the Fluxion of it, a Cyllindrick Superficies, whose Altitude is the Fluxion of the Curve, and whose Distance from the Axis is the Ordinate Applicate corresponding to that Fluxion. *Ex.gr.* Let  $AC$  be the Arch of a Circle, which turning round the Axis  $AD$ , generates a Spherical Superficies, which we would measure. Now  $DC$  the Fluxion of the Arch is already found to be =

$$\frac{r\dot{x}}{\sqrt{2rx - xx}}, \text{ which if we multiply by the Peri-}$$

phery belonging to the Radius  $BC$ , that is, by  $\frac{c}{r}\sqrt{2rx - xx}$  (putting  $\frac{c}{r}$  the Ratio of the

Cir-



Circumference to the Radius) we shall have *c. x.* for the Fluxion of the Spherical Superficies, and consequently that Superficies it self, is *c. x.*

RECTIFIABLE, [of *Rectificare*, L.] capable of being set to rights.

RECTIFICATION, a rectifying or making right, the remedying or redressing some Defect or Error either of Nature, Art, or Morality.

To RECTIFY, [*Rectificare*, L. of *Rectifier*, F.] to set to rights what is amiss, to correct, or mend.

To RECTIFY a Nativity, [with *Astrologers*,] is to bring the estimated and supposed Time of a Person's Birth, to the real and true one.

RECTILINEAL, or Right-lined, [in *Geometry*] is spoken of such Figures as have their Extremities all Right Lines.

RECTI *Minores*, are two small Muscles of the Head, appearing both in Sight at once: They arise fleshy from the Posterior Part of the first *Vertebrae* of the Neck; and are so inserted to the middle Part of the *Os Occipitis* in two shallow Depressures of the said Bone. These from their Use may be called *Renuentes* or Noddors backwards, and are Antagonists to those we call *Annuentes*.

RECTITUDE, [*Rectitudo*, L.] refers either to the Act of Judging or Willing, and is either what is true or what is good; these being the only Objects about which the Mind exercises its two Faculties of Judging and Willing.

RECTO, is a Writ of Right, and is of so high a Nature, that whereas other Writs in real Actions are only to recover the Possession of Lands or Tenements in Question, which have been lost by our Ancestors or our selves; this aimeth to recover both the Seisin, which some of our Ancestors or we had, and also the Property of the Thing whereof the Ancestor died not Seized, as of Fee, and whereby are Pleaded and Tried both their Rights together, viz. as well of Possession as Property: So that if a Man once lose his Cause upon this Writ, either by Judgement, Assize, or Battle, he is without all Remedy, and shall be excluded *per exceptionem rei Judicatae*.

It is divided into two Kinds, *Rectum Patens*, a Writ of right Patent; and *Rectum Clausum*, a Writ of right Close. This the *Civilians* call *Judicium Pettitorum*. The Writ of right Patent is so called, because it is sent upon, and is in Nature the highest Writ of all others, lying always for him that hath Fee-simple in the Lands or Tenements sued for, and not for any other. And when it lyeth for him that Challengeth, Fee-simple, and in what Cases, see *F. N. B. Fol. 1. 6.* This Writ is also called *Breve magnum de recto*. A Writ of right Close, is a Writ directed to a Lord of *Ancient Demesne*, and lieth for those which hold their Lands and Tenements by Charter in Fee-simple, or in Fee-Tail, or for Term of

Life, or in Dower, if they be ejected out of such Lands, &c. or disseised. In this Case, a Man or his Heirs may sue out this Writ of right Close, directed to the Lord of the *Ancient Demesne*, commanding him to do him right, &c. in his Court. And this is called, *Breve parvum de recto*.

RECTO de *Advocatione Ecclesiae*, is a Writ of Right lying where a Man hath right of Advowson, and the Parson of the Church dying, a Stranger presents his Clerk to the Church, and he not having brought his Action of *Quare Impedit* nor *Darrein Presentment* within Six Months, but suffered the Stranger to usurp upon him. And this Writ he only may have, that claimeth the Advowson to himself, and to his Heirs in Fee; and as it lieth for the whole Advowson, so it lieth also for the half, third or fourth Part.

RECTO de *Custodia terrae & heredis*, was a Writ that lay for him whose Tenant holding of him in Chivalry, died in Nonage against a Stranger that entered upon the Land, and took the Body of the Heir; and is now become useless as to Lands holden in *Capite*, or by *Knights Service*, but not when there is Guardian in *Socage*, or appointed by the last Will and Testament of the Ancestor.

RECTO de *Dote*, is a Writ of Right of Dower, which lieth for a Woman that hath received Part of her Dower, and purposes to demand the Remainder in the same Town, against the Heir, or his Guardian, if he be a Ward.

RECTO de *Dote unde nihil habet*, is a Writ of Right, which lies in Case where the Husband having divers Lands or Tenements, hath assuured no Dower to his Wife; and she thereby is driven to sue for her Thirds, against the Heir or his Guardian.

RECTO de *rationabili Parte*, is a Writ that lies always between Privies of Blood; as Brothers in *Gavel-kind*, or Sisters, or other Co-parceners, as Nephews or Nieces, and for Land in Fee-simple; as if a Man lease his Land for Term of Life, and afterward dies, leaves Issue two Daughters, and after that the Tenant for Term of Life dieth also, the one Sister entreteth upon all the Land, and so deforcing the other, the Sister so deforced shall have this Writ to recover Part.

RECTO quando *Dominus remisit*, is a Writ of Right, which lies in Case where Lands or Tenements being in the Seigniorship of any Lord, are in Demand by a Writ of Right; for if the Lord hold no Court, or otherwise, at the Prayer of the Demandant, or Tenant, shall send to the Court of the King his Writ, to put the Cause thither for that Time, (saving to him at other Times the Right of his Seigniorship) then the Writ issues out for the other Party, and hath the Name from the Words contained, being the true Occasion thereof. This Writ is *Close*, and must be returned before the Justices of the *Common-Bench*.



**RECTO** *sur Disclaymer*, is a Writ that lies when a Lord in the King's Court of Common-Pleas avows upon his Tenant, and the Tenant disclaimeth to hold of him; upon which Disclaymer he shall have this Writ; and if the Lord averr and prove, That the Land is held of him, he shall recover the Land for ever.

**RECTOR**, a Governor or Ruler; also a Parson of a Parish-Church, whose Office is to take Care of the Souls of his Parishioners, to preach, to administer the Sacrament, &c. Also the Chief of a Foreign University, or of a Convent of Jesuits; also the Principal or Head of a College in England.

**RECTORY**, [*Reſtoria*, L.] a Parish-Church, Parsonage, or Spiritual Living, with all its Rights, Glebes, Tithes, &c.

**RECTUM** *Intestinum*, is the strait Gut which begins at the first *Vertebrae* of the *Os Sacrum*, and passeth strait downward to the Extremity of the *Rump*, or utmost End of the Back-bone. It is about a Foot in Length, and not so wide as the *Colon*, but its Membranes are thicker.

**RECTUM**, was used formerly for a Trial: *Commune Rectum*, was a Trial at Law; or in common Course of Law: And *Stare ad Rectum*, was to stand Trial.

**RECTUS Abdominis**, a Muscle of the lower Belly, which arises from the *Sternum*, and the Extremity of the last two Ribs, and goeth strait down to the fore-part of the *Abdomen*, to be inserted in the *Os Pubis*.

**RECTUS Femoris**, is a Muscle of the Leg, so named from its strait Progress and Situation; it arises fleshy from the Tubercle of the *Os Ilium*, that is in the Mid-way between the fore-part of its Spine and the *Acetabulum*, from thence descending directly between the *Vastus Externus* and *Internus*, and over the *Crureus*. Its Fibres externally descend from a middle Line obliquely Laterally: Internally they run according to the Length, and become entirely Tendinous four Fingers breadth above the *Patella*, where it is united with the Tendons of the *Vastus Externus* and *Internus*, and *Crureus*, and inserted together with 'em at the upper Part of the *Tibia*. It serves to help to extend the *Tibia*.

**RECTUS in Curia**, signifies one that stands at the Bar, and no Man objects any thing against him. Also, when a Man hath reversed the Outlawry, and can participate of the Benefit of the Law, he is *Rectus in Curia*.

**RECTUS Internus Major**, is a Muscle of the Head which arises Tendinous, but chiefly Fleshy, from the fore-part of all the Transverse Processes of the *Vertebrae* of the Neck, except the first and second, and in its Ascent becoming Fleshy, passes over those two superior *Vertebrae*, and is inserted to the Anterior

Appendix of the *Os Occipitis*, near the great Foramen, that transmits the *Medulla Oblongata*. This manifestly bends the Head forwards, and therefore may be called *Flexor Capitis*, from its Use.

**RECTUS Internus Minor**, is a Muscle of the Head, which with its Partner appears on the Fore-part of the first *Vertebra*, like the *Recti Minores* on the Back part, and arise near its Transverse Processes, and ascending directly, are inserted to the Anterior Appendix of the *Os Occipitis*, immediately under the former. These nod the Head forward, and are Antagonists to the *Recti Minores*. Wherefore they may be called *Annuentes*.

**RECTUS Lateralis** is a short, thick, fleshy, Muscle of the Head, arising from the superior part of the Extremity of the Transverse Process of the first *Vertebrae* of the Neck, between the former and *obliquus Superior*, thence ascends directly to its Insertion to the *Os Occipitis* in the Interstice made by the *Processus Mammillaris* and *Styloides*. This nods the Head to one side.

**RECTUS Major**, is a Muscle of the Head, which ariseth partly Tendinous, but chiefly Fleshy, from the Superior Part of the double Spines of the second *Vertebrae* of the Neck, and in its ascent becomes broader and Fleshy, and is so inserted to the posterior Part of the *Os Occipitis*; This Muscle with its Partner acting, pulls the Head directly back on the first *Vertebrae*.

**RECTUS Musculus**, one of the Muscles of the *Abdomen* so called from the Uprightness of its position. Its Use in common with the other Muscles of this Part, is to help to exclude the *Feces* and *Urine*, by the compression of the *Abdomen*.

**RECTUS Palpebrae Superioris**, is a Muscle which lifts up the upper Eye-lid.

**RECURRENT Nerves**, by some called *Vocal* because they are spent upon the Instruments of Speech and which *Galen* saith he tried to cut, and by that means rendred the Animal Mute. This *Dr. Willis* takes to be a Distinct Pair by its self, but 'tis usually reckoned a Branch of the *Par-vagus* or eighth Pair springing out of their Trunks, and so called, because first they descend, and then ascend again to supply the Muscles of the *Larynx*.

**RECUSANTS**, [*Recusantes*, L.] Persons who refuse to acknowledge the King's Supremacy; properly *Roman* Catholicks, who refused to submit; but it hath been extended to comprehend all who separate from the established Church of England, of whatsoever Sect or Opinion.

**RECUSATION**, [in Law,] an Act whereby a Judge is desir'd to refrain from judging some certain Cause, on Account of his being related to one of the Parties, of some Capital Enmity, or the like.



**RED** [in *Physicks*] is one of the simple or primary Colours of natural Bodies, or rather of the Rays of Light.

The *Red Rays* are the least refrangible of all others, and hence Sir *Isaac Newton* supposes, the different degrees of Refrangibility to arise from the different magnitudes of the luminous Particles of which the Rays consist. The *Red Ray* or *Red Light* is concluded to be that which consists of the largest Particles.

Authors distinguish three general kinds of *Red*, one bordering on the *Blue*, as *Columbine* or Dove-colour, Purple and Crimson.

Another bordering on the *Yellow*, as Flame-colour and Orange.

**REDDITARIUM** [old Law] a terrier Roll or Rental, in which the Rents and Services of a Manour are set down.

**REDDENDUM**, a Word used substantively for the Clause in a Lease, &c. whereby the Rent is reserved to the Lessor.

**REDDITION**, is a Judicial Confession and Acknowledgment, that the Land or Thing in demand, belongs to the Demandant, or at least not to the Person so surrendering.

**REDEMPTION** [in Law] a Faculty or Right of re-entring upon Lands, &c. that have been sold and assign'd, upon repaying the Purchase Money, with legal Costs.

**REDEMPTIONS** [in ancient Law] are grievous Mulcts impos'd, by way of Commutation, for the Head or Life of the Delinquent.

**REDENT** [in Fortification] is a Work made in form of the Teeth of a Saw, with *Saliant* and *Re-entring Angles*, to the end that one part may defend another. These sort of Works are usually erected on that side of a Place which looks towards a Marsh or River.

**RED Book of the Exchequer** is a MS. Vol. of several miscellany Treaties, in the keeping of the King's Remembrancer in that Office; in it are the Number of the Hides of Land, in many Counties, before the Conquest, &c. See *Bishop Nicholson's Hist. Library*.

**REDHIBITION** [in the Civil Law] an Action in a Court to annul the Sale of some Moveable, and to oblige the Vendor to take it back again, upon the Buyer's finding it damaged, or proving that there was some personal Cheat, &c.

**REDINTEGRATION**, a restoring any mixt Body or Matter whose Form is destroyed, to the same Nature and Constitution; and that it shall have the same Properties it had before.

The Honourable Mr. *Boyle* hath a particular Tract about the *Redintegration* of Salt-Petre; in which he proves, that after Nitre had been fluxed in a Crucible over a strong Heat, and after all its volatile Parts had been forced away by the injection of lighted Coals so often into the Crucible, that no farther Detonation would happen; by which means the Salt-Petre was turned into that Body which is called *Fixt Nitre*, and which is very nearly a-kin, in all its Properties, to fixt Salt of Tartar; yet he could very speedily, by pouring to this fixt Salt-Petre, either diluted with a due proportion of Water, or let run *per se* into a *Deliquium*, a sufficient quantity of Spirit of Nitre, (which, by the bye, amounted to nearly the quantity of that volatile Part which was burnt off) he could, I say, suddenly re-produce true Crystals of Salt-Petre of the common Form and Virtue.

**RED-seer**, when a Piece of Iron in a Smith's Fire of his Forge is heated too much, it will *Red-seer*, as they call it, that is, break or crack under the Hammer, while it is working between hot and cold. Some call this *Red-shire*.

**REDISSEISIN**, is a *Disseisin* made by him that once before was made and adjudged to have *Disseised* the same Man of his Lands or Tenements; for which there lies a special Writ, called a Writ of *Redisseisin*.

**RED-Lead**, how made. See *Minium*.

**REDOUBT** [in Fortification] is a small Fort of a square Figure, having no defence but in the Front, its use being to maintain the *Lines of Circumvallation, Contravallation, and Approach*. In marshy Grounds these *Redoubts* are often made of Mason's Work for the Security of the Neighbourhood. Their *Face* consists of from ten to fifteen Fathom; the Ditch round about being from eight to nine Foot broad and deep, and their *Parapets* having the same thickness.

**REDUBBORS**, are those which buy stolen Cloth, knowing it such, and change it into some other Form or Colour that it may not be known.

**REDUCING-Scale**, is a thin broad piece of Box with several different *Scales* of equal Parts, and Lines to turn Chains and Links into Acres and Rods, by Inspection; and is used by Surveyors to reduce any Map or Draught. It is sometimes called, the *Surveying-Scale*.

**REDUCT**, a military Term, signifying an advantageous piece of Ground, entrenched and separated from the rest of the Place, to retire to in case of Surprise.

**REDUCT** [in Architecture] a Quirk or small Place taken out of a larger to render it more uniform and regular, or for making a Cabinet, a Leaf, or some other Convenience.

**REDUCT** [in Chymistry] a knot of Powder by which calcin'd Metals or Minerals are again reduced to their *Regulus* or pure Substance.

**REDUCTION** [in Surgery] an Operation by which a dislocated, luxated, or fractured Bone is restored to its former Place.

**REDUCTION** [in Astronomy] is the difference between the Argument of Inclination and the Eccentric Longitude; that is to say, the difference of the two Arches of the Orbit, and the Ecliptick, intercepted between the Node and the Circle of Inclination.

**REDUCTION of Decimals.** See *Decimals*.

**REDUCTION of Equations**, [in Algebra] is the clearing of them from all superfluous Quantities, and the separating of the known Quantities from the unknown, to the end that at length every respective Equation may remain in the fewest and simplest *Terms*, and so disposed, that the known Quantity or Quantities may possess one part thereof, and the unknown the other. See *Equation*.

**REDUCTION of Fractions.** See *Fractions*.

**REDUCTION of Money, Weights, Measures, &c.** is of two kinds. 1. When a Quantity is to be brought from any higher Denomination into a lower, and this is done, by considering how many of the next lesser Denomination are contained in the next greater before, and by that Number multiplying the greater; as *Pounds* are brought into *Shillings* by multiplying by 20; *Shillings* into *Pence* by 12; and *Pence* into *Farthings* by 4. Also, *Troy Weight* may be reduced into Grains, by multiplying by 12, 20, and 24. And *Averdupois Great Weight* into Ounces, by 4, 28, and 16.



2. if it be to bring the lower to a higher, then divide the least by so many of its Denominations as are contained in the next greater. Thus 24720 Pence is 103 Pounds : But if there remains any thing after Division, they are the odd Pence and Shillings ; as 6713 Pence reduced, gives 27*l.* 19*s.* 5*d.*

*Note,* That the way to reduce Shillings into Pounds, is to cut off the last Figure, and take half of the rest, as in the last Instance.

13) 6713 ( 551|9 (27*l.* 19*s.* 5*d.*

71  
—  
1113  
—  
5*d.*

After the same manner may *Troy Weight*, *Averdupois Weight*, or any other Weight or Measure be reduced.

Likewise *Foreign Coin* may be reduced into *English*, by turning the Value into *English Coin* of any Part : As, what is the value of 223 *Scotch Marks*, each equal to 13*d.*  $\frac{1}{2}$  *English* ? which is 54 Farthings, and 223 by 54 = 12042 Farthings, which reduced backwards to Pounds, Shillings and Pence, makes 12*l.* 18*s.* 10  $\frac{1}{2}$  *d.*

REDUNDANT *Hyperbola* is a Curve of the higher kind, so called because it exceeds the Conic-Section of that Name in the number of its hyperbolical Legs, being a triple *Hyperbola* with 6 hyperbolical Legs.

REDUPLICATIVE *Propositions*, are such wherein the *Subject* is repeated : Thus, Men, as Men, are Rational ; Kings, as Kings, are subject to none but God.

RE-ENTRING *Angle*, a Term in *Fortification*, See *Angle*.

RE-ENTRY [in *Law*] signifies the resuming and retaking that Possession which he had lately forgone : As if I make a Lease of Land or Tenement, I do therefore forego the Possession ; and if I do condition with the Lessee, That for Non-payment of the Rent at the Day, it shall be lawful for me to *Re-enter* ; this is as much as if I condition'd to take again the Lands, &c. into my own Hands, and to recover the Possession by my own Fact, without the assistance of Judge or other Process.

REEF, a Term in Navigation : When there is a great Gale of Wind, they commonly roll up part of the Sail below, that by that means it may become the narrower, and so draw not so much Wind. And this contracting or taking up the Sail, they call a *Reef*, or *Reefing the Sail* ; and when it is done they say, *the Sail is Reefed*.

Also, when a Top-Mast is *Sprung*, as they call it, *i. e.* crakt or almost broken in the Cap, they cut off the lower piece that was near broken off, and setting the other part, now much shorter, in the Step again, they call it a *Reeft Top-Mast*.

RE-Extent [in the *Law*] is a *Second Extent* made on Lands or Tenements, on a Complaint made that the former *Extent* was partially performed.

REEVE, is to put a Rope through a Block ; and to pull a Rope out of a Block, is called *Unreeving*.

REEVE of a Church, is the Guardian of it ; or the Church-Warden ; as *Shire-Reeve* is the Sheriff or Guardian of a County ; and *Port-Reeve* the Warden of a Port or Haven.

REFECTORY, was that Place in a Monastery where the Monks, Friars, Nuns, &c. usually Dined and Supped.

REFERENDARY, *Referendarius*, was a Term used by the old Saxons, as appears by *Grants* and *Charters*, for such a Person as a *Master of Requests* was to the King or Queen, amongst us before the Court of *Requests* was taken away by 16, 17 *Car. I.* See *Court of Requests*.

REFINING is the Art of separating all other Bodies from Gold and Silver, and this is performed four ways.

The end of *Refining* is the Separation of all other Bodies from Gold and Silver, which is performed four ways, *viz.* by *Parting*, by the *Test*, by the *Almond Furnace* or the *Sweep*, and by *Mercury*. 1. *Parting* is done with the *Aqua fortis*. Some Refiners, to make the *Aqua fortis*, take *Salt-Petre* three pounds, and *Dantzick* (not *English*) *Vitriol* two pounds (for the *English Vitriol* makes a weaker Water, and dirty colour'd *Verditer*, and wholly spoils it.) After they are well bruised and mixed in a Mortar, they distil 100 pound of the Materials, put into a Cast-Iron Pot, after this manner.

Build a Furnace two Yards high, or more, and at the top place your Iron-Pot ; to which fit a Head of Earth, like the Head of a large *Distillation* for *Chymical Oils*, which must have a large Belly, branching itself out eight Inches from the Iron-Pot into three Branches, one whereof in the midst comes directly strait forward, two other lateral ones come obliquely : All which Branches are four or five Inches hollow in Diameter, and five or six long. To these Branches are fitted Glass Bodies, narrow and hollow at both Ends, large and globous in the midst. These must be exceedingly well luted on with Colcothar, Rags, Flour and Whites of Eggs. To the first Glass Body is luted on another Glass, of the same Figure and Size, and in order eight, alike in all, till they come to the Receiver, which is an ordinary Gallon Glass. All these Rows of Glasses lie on Boards shelving from the Head to the Receiver. The two upper Receivers or Glass Bodies need exceeding good luting, for the rest ordinary Lute will serve.

The Lute is made of good Lome, some Horse-dung, and a little Colcothar ; although the two former do well.

A little Fire and that of *Newcastle Coals* does the Work. And you need never break or unlute any of the Receivers, but the lowermost.

The *Aqua fortis* being distilled off, is put into a large Earthen Pot, and there is added of fine Silver, one or two Penny-weight (which is called *Fixes*) to every Pound of *Aqua-fortis*, which within four Hours will purge it from all Dirt and Impurity, and make it fit for parting, which is thus done.

If their Silver-Gilt be fine enough for Wire, they only melt it in a Wind-Furnace, and Cast it, melted, into a large Tub of Water, that they may have it in small Pieces ; but if it be but Standard, they first fine it on the Test. These small Pieces taken from the Water, being well dried, are put into a Glass Taper-fashion'd, a Foot high, and seven Inches at the bottom ; and then the Glasses are charg'd with *Aqua-fortis* about two Thirds of it, and set in a Range of Iron covered two Inches deep with Sand, and a gentle Charcoal Fire is made under it.



Small Bubbles will soon arise, and the Water also run over. If so, they take off the Glasses, and hold them till it doth *Defervesce*, or else pour out some of it into a Vessel which is at hand.

If Lead be mixed with it, they cannot keep it from running over.

When the Water hath been once quieted from the Ebullition, it will rise no more.

The Greenness of the Water, manifesteth the Quantity of Copper contained in it.

If the Water boil over, 'twill penetrate the Bricks and Wood.

They commonly let it stand a Night on the Iron Range with a gentle Heat under it, and in the Morning softly pour off the Water impregnated with all the Silver; all the Gold lying like black Dirt at the bottom; which being washed out is put into small parting Glasses, and set over the Sand with their Conduit Water for an Hour, and then the Water poured off. This is repeated five or six times, to separate the Salt from the Gold, which is now fit to be melted, and cast into Ingots.

To regain the Silver, they have large round Washing Bowls, lined within with melted Rosin and Pitch (for otherwise the Water would eat the Wood, and penetrate the Sides of the Bowl) covered with Copper Plates ten Inches long, six wide, and half or more thick. Into which Bowls they pour good store of Water (the more, the better the *Verditer*) and then the Silver Water, which working on the softer Metal of Copper, leaves all the Silver in moist fine Sand at the bottom, and sides of the Bowl, and Plates of Copper; which being taken out, is washed, dried and melted for any Use.

If any Brass or shroffe Metal be in the Plates, they gather very little of the Silver; the latter mixing with the Silver.

With the the *Copper-Water* poured off from the Silver, and *Whiting, Verditer* is made thus. They put into a Tub a hundred Pound Weight of Whiting, and thereon pour the Copper Water, and stir them together every Day, for some Hours together. And when the Water grows pale, they take it out, and set it by for farther Use, and pour on more of the Green Water; and so continue till the *Verditer* be made; which being taken out, is laid on large Pieces of Chalk in the Sun, 'till it be dry for the Market.

The Water mention'd to be taken from the *Verditer*, is put into a Copper, and boiled till it comes to the Thickness of Water-Gruel, now principally consisting of *Salt-Peter* deduced, most of the *Spirit of Vitriol* being gone with the Copper into the *Verditer*) a Dish full whereof being put into the other Materials for *Aqua-fortis*, is Re-distilled, and makes a double Water, almost twice as good as that without it.

2. By the *Test*, all Metals are separated from Silver, except Gold, because they swim over it, when they are all melted together.

The *Test* is thus made. They have an Iron Mould, oval, and two Inches deep. At the Bottom hereof are three Arches of Iron, set at equal Distances, two Fingers wide, if the great Diameter of it be 14 Inches long; and so proportionable in greater or lesser *Tests*. This Cavity they fill with fine Powder of Bone-Ashes, moistened with *Lixivium*, made with Soap-Ashes. Some use Cakes of Pot-Ashes, or other Ashes well cleansed, and so pressed well together with a *Muller*, that it be-

comes very close and smooth at the Top. There is left above, a Cavity in the midst of it, to contain the melted Silver. This Cavity is made greatest in the middle; for the Bone-Ashes come up parallel to the Circumference of the Mould; only a small Channel in that End, which is most remote from the Blast, for the running off of the baser *Metals*, and so is made declive to the Center of the *Test*, where 'tis not above half an Inch deep.

The *Test* thus made, is set annealing 24 Hours, and then 'tis set in a Chimney a Yard high, parallel almost to the Nose of a great Pair of Bellows; and then therein is put the Silver: Which being covered all over with Billets of barked Oak, the Blast begins, and continues all the while strongly. The Lead, purify'd from all Silver, (which they call the *Soap of Metals*) first put in, melts down with the *Silver*, and then the Lead and Copper swim at the Top, and run over the *Test*. Whose Motion the Refiner helps with a long Rod of Iron drawn along the Surface of the Silver towards the fore-mention'd Slit; and often stirring all the Metal, that the impurer may the better rise; and by continuing this Course, *Separation* is made in two or three Hours.

The greatest part of the Lead flies away in Smoak.

If the Lead be gone before all the Copper, 'twill rise in small red fiery Bubbles; and then they say the *Metal drives*, and must add more Lead. The Force of the Blast drives the higher *Metals* to the lower side of the *Test*, and helps its running over.

When the Silver is fully fined, it looks like most pure *Quicksilver*; and then they take off their *Sogs* and let it cool. In the cooling, the Silver will frequently from the middle, spring up in small Rays, and fall down again. If moist Silver be put into that which is melted, 'twill spring into the Fire.

A good *Test* will serve two or three Firings.

So soon as the Silver will hold together, they take it out of the *Test*, and beat it on an Anvil into a round Figure, for the melting Pot; which being set in a Wind Furnace surrounded with Coal, and covered with an Iron Cap, that no Charcoal fall into it, is then melted.

If any Dross or Filth be in the melting Pot, they throw in some *Tincal*, which gathers the Dross together, that it may be separated from it.

These melting Pots are never burned, but only dried, and last a whole Day, if they be not suffered to cool; but if they once cool, they infallibly crack.

3. In the *Almond Furnace* or *Sweep*, all sorts of *Metals* are separated from Cinders, parts of melting Pots, Tests, Brick, and all other harder Bodies; which must be first beaten into small Pieces with a Hammer on an Iron Plate.

Those which stick but superficially to the Silver, they wash off thus; they have a wooden round Instrument two Foot wide, somewhat hollow in the middle, with a Handle on each side. On this they put the Materials, and hold them in a Tub of Water below the Surface, and so waving it to and fro, all the lighter and looser matter is separated from the *Metal*.

The Furnace is six Feet high, four Feet wide, and two Feet thick, made of Brick; having a Hole in the midst, at the Top eight Inches over, growing narrower towards the Bottom of it, where



on the Fore-part, it ends in a small Hole, environed with a Semi-circle of Iron, to keep the *molten Metal*. About the middle of the Back, there is another Hole to receive the Nose of a great Pair of Bellows.

When the Furnace is annealed with Charcoal and hot, they throw two or three Shovels of Coal to one of the forementioned Stuff, and so proceed during the whole Work, which continues three Days and Nights, without Intermiſſion. After eight or ten Hours the Metal begins to run; and when the Receiver below is pretty full, they lade it out with an Iron Ladle, and caſt it into Sows in Cavities, or Forms, made with Aſhes.

They frequently ſtop the paſſage Hole with Cinders to keep in the Heat; and when they think a Quantity of *Metal* is melted, they unſtop the Hole to paſs it off.

If the Stuff be hard to Flux they throw in ſome *Slag* (which is the recrement of Iron) to give it Fulion.

A ſtinking blue Smoak proceeds from the Furnace, and all By-ſtanders put on the Colour of dead Men.

To get the Silver from thoſe Metals, and to refine their Copper from the Litharge, they now uſe no other Art than that of the *Teſt*.

4. By *Quickſilver* the Filings of Gold and Silver are ſeparated from Duſt, &c. This Duſt is put into a Hand-mill with Quickſilver, and being continually turned upon that and the *Metals*, an *Amalgama* is made of them, and fair Water poured in, carries off the Duſt as it runs out again by a ſmall Quill.

This *Amalgama* is put into an Iron, with a Bolt head ſet into the Fire, having a long Iron Neck three Feet long, to which is fitted a Receiver. The Fire diſtills off the *Mercury* into the Receiver, and the Gold and Silver remains in the Bolt-head.

**REFLECTED Dialling** is the Art of deſcribing Hour-lines, Azimuths, Parallels of Declination, or of Altitude, &c. and all the Furniture of Dials; on ſuch Places as the Suns direct Rays can never come to directly, but only by the help of ſome reflecting Surface; as ſuppoſe on the Ceiling of a Room, &c. where the Beams may be reflected by a piece of Looking-Glaſs placed on the Board Stool or Tranſome of a Window; or other convenient place: And this may be done either by a Glaſs placed horizontally, or at oblique Angles to the Horizon.

1. If the Glaſs be placed horizontally, you may by the following Method upon any Wall or Ceiling of a Room, where that Glaſs can reflect a Spot of Light, draw true Hour Lines, Furniture, &c. tho' the Surface be never ſo irregular, as convex, concave, or of any form whatſoever.

Fiſt, draw on Paſtboard or other material, or get made in Braſs an Horizontal Dial for the Latitude propoſed.

Then by the help of the Azimuth, or at the time when the Sun is in the Meridian; or by knowing the true Hour of the Day, whereby may be drawn ſeveral Lines on the Ceiling, Floor, and Wall of the Room; ſo as in reſpect of the Centre of the Glaſs they may be in the true Meridian-Circle of the World: For if right Lines were extended from the centre of the ſaid Glaſs by any Point, tho' elevated in any of thoſe Lines ſo drawn, it would be directly in the meridian Circle of the World.

Now all reflective Dialling is performed from that Principle in Opticks, which is, *That the Angle of Incidence is equal to the Angle of Reflection*. And as any direct Dial may be made by help of a Point found in the direct Axis, ſo may any reflected Dial be alſo made by help of any Point found in the reflected Axis.

And in regard the reflected Axis for the moſt part will fall above the Horizon of the Glaſs without the Window, ſo that no Point there can be fixed, therefore a Point muſt be found in the ſaid reflected Axis continued below the Horizontal of the ſaid Glaſs, until it touch the Ground or Floor of the Room in ſome part of the Meridian formerly drawn, which Point will be the Point in the reverſed Axis deſired, and may be found, as followeth.

One end of the Thread being fixed at or in the centre of the ſaid Glaſs, move the other end thereof in the Meridian formerly drawn below the ſaid Glaſs, until the ſaid reverſed Axis be depreſſed below the Horizon, as the direct Axis was elevated above the Horizon, which may be done by applying the Side or Edge of a Quadrant to the Thread, and moving the end thereof to and fro in the ſaid Meridian, until the Thread with a Plummet cut the ſame Degree as the Pole is above the Horizontal Glaſs, and then that Point where the end of the Thread toucheth the Meridian either on the Floor or Wall of the Room, is the Point in the reflected reverſed Axis ſought for.

Now if the reverſed Axis cannot be drawn from the Glaſs by reaſon of the jetting of the Window or other Impediment, that Point in the reverſe Axis may be found by a Line parallel thereto, by fixing one end of it on the Glaſs, and the other end in the Meridian, ſo as that it may be parallel to the Floor or Wall in which the reverſed Axis Point will fall, and find the Axis Point from that other end of the Lath: ſo if the ſame Diſtance be ſet from that Point backward in the Meridian on the Floor, as is the Lath, the Point will be found in the reverſed Axis deſired.

Thus having found a Point in the reflected reverſed Axis, it is not hard, by help thereof and the Horizontal Dial, to draw the reflected Hour-lines on any Ceiling or Wall, be it never ſo Concave or Convex.

To do which; Fiſt note, that all ſtrait Lines in any Projection or any Plane, do always repreſent great Circles in the Sphere, ſuch are all the Hour Lines.

Place the centre of this Horizontal Dial in the centre of the Glaſs, the Hour Lines of the ſaid Dial being horizontal; and the meridian of the World, which may be done by Plumb Lines, let fall from the meridian on the Ceiling: Then fix the end of a Thread or Silk in the ſaid centre of the Dial or Glaſs, and draw it directly over any Hour Line on the Dial which you intend to draw at the further ſide of the Room, and there let one hold or faſten that Thread with a ſmall Nail.

Then in the Point formerly found on the reverſed Axis on the Floor, fix another Thread there (as formerly was done in the centre of the Dial) then take that Thread, and make it juſt touch the Thread (on the Hour Line of the Horizontal Dial extended) in any Point thereof, it matters not whereabouts, and mark where the end of that Thread toucheth the Wall or Ceiling, and there make ſome Mark or Point.

Then again move the ſame Thread higher or lower



lower at pleasure, 'till it, as formerly, touch the said same Hour-Thread, and mark again whereabouts on the Wall or Ceiling, the end of the said Thread also toucheth. In like manner may be found more Points at pleasure, but any two will be sufficient for the projecting or drawing any Hour-line on any Plane, how irregular soever. For if you move a Thread, and also your Eye to and fro, until you bring the said Thread directly between your Eye and the Points formerly found, you may project thereby as many Points as you please at every Angle of the Wall or Ceiling, whereby the reflected Hour-line may be exactly drawn.

Again, in like manner, remove the said Thread fastened in the centre of the Horizontal Dial, (which also is the centre of the Glass) on any other Hour-line desired to be drawn, and, as before, fasten the other end of the Thread, by a small Nail, or otherwise at the further side of the Room, but so that the said Thread may lie just on the Hour-line proposed to be drawn on the Horizontal Dial. Then (as before) take the Thread fastened in the Point on the reflected Axis, and bring it to touch the Thread of the Hour-line in any part thereof, and mark where the end of that Thread toucheth the said Wall or Ceiling: Then again (as before) move the said Thread so, as that it only touch the said Thread of the Hour-line in any other part thereof, and also mark where the end of that Thread toucheth the said Wall or Ceiling: So is there found two Points on the Wall or Ceiling, being in the reflected Hour-line desired, by help of which two Points the whole Hour-line may be drawn; for if (as before) a Thread be so situated, that it may interpose between the Eye and the said two Points found, you may make many Points at Pleasure, whereunto the said Thread may also interpose, which for more Convenience may be made at every Angle or bending of the Wall or Ceiling, be they never so many: So that if Lines be drawn from Point to Point, that said reflected Hour-line will be also exactly drawn.

In like manner may the Hour-lines be drawn so, that the Reflex or Spot of the Sun from the said Horizontal Glass situated in the said Window (as before) shining amongst the said reflected Hour-lines drawn on the Wall or Ceiling, will exactly shew the Hour of the Day desired.

Now if Lines be drawn round about the said Room, equal to the Horizon of the said Glass, it will shew when the Sun is in or near the Horizon.

*To draw the Æquator and Tropicks on any Wall or Ceiling to any horizontal reflecting Glass.*

1. *To draw the reflected Æquator or Equinoctial Line on the Wall or Ceiling, which represents a great Circle.*

Take the Thread fixed in the Centre of the Glass, and move the End thereof to and fro in the Meridian-line drawn on the Ceiling, until by help of a Quadrant the said Thread be elevated equal to the Complement of the Latitude (which will be always perpendicular to the reversed Axis) marking in the Meridian where the end of that Thread falls; then on that Point and the said Meridian Line on the Ceiling erect a perpendicular Line, which Line may be continued on any Plane

whatsoever, and is the reflected Equinoctial Line desired.

*Note*, That all great Circles are right Lines, and are always drawn or projected from a right Line.

2. *To draw the Tropicks. Note, that all Parallels of Declination are lesser Circles, and are Conick Sections.*

First, make or take out of some Book a Table of the Sun's Altitude for each Hour of the Day calculated for the Place of the Latitude proposed, when the Sun is in either of the Tropicks. Then take the Thread fixed in the Centre of the Glass, and by applying one Side of a Quadrant to the said Thread, and moving one End of it to and fro in the Hour-line proposed, elevate the said Thread answerable to the Sun's Height in that Hour, when he is in the Tropick you desire to draw, and mark where the End of that Thread so elevated toucheth in that Hour-line proposed. So may you in like manner find a several Point in each Hour-line for the Sun's Height in that Tropick, whereby a Line may be drawn on the Wall or Ceiling from Point to Point, formerly made in the said Hour-lines, which is the Tropick desired.

In like manner may any Parallel of Declination be drawn: If there be first calculated a Table of the Sun's Altitude at all Hours of the Day, when the Sun hath any Declination proposed, whereby may be drawn either the Parallels of the Sun's Place, or the Parallels of the Length of the Day.

*To draw the Parallels of Declination to any reflected Glass most easily, by help of a Trigon first made on Past-board or other Material.*

Fix the Trigon to the reflected reversed Axis, so that the Centre of the Trigon may be in the Centre of the Glass, then will the Equinoctial on the Trigon be perpendicular to the said Axis: Then take the Thread fixed in the Centre of the Glass, and lay it along either of the Tropicks, or other Parallels of Declination required, which is drawn on the said Trigon, which Thread must be continued so, that the End thereof may touch any Hour-line, and on that Hour-line mark the Point of Touch, the Thread being still laid on the same Parallel of Declination on the Trigon: In the same manner find a Point in each Hour-line. Lastly, draw a Line by those Points so found, which will be the Tropick-line or other Parallel of Declination, as the Thread was laid on, on the Trigon.

*To draw the Azimuth-lines on any Wall or Ceiling to any horizontal reflecting Glass. Note, that all Azimuths are great Circles.*

First, find a Vertical-point, either above to the Zenith, or below to the Nadir of the Glass, (by some called a Perpendicular or Plumb-line) and mark in what Point it cuts the Floor of the Room, which Point I call the reflected Vertical-point, wherein the End of a Thread is to be fixed: For by a Point found in the reflected Axis of the Horizon the Azimuths may be drawn, as by a Point found in the reflected Axis of the Equinoctial the Hour-lines may be drawn.

Then on Past-board or other Material draw the Points of the Compass or other Degrees, and fix the Centre thereof in the Centre of the Glass, and the Meridian thereof in the Meridian of the World,



as was shewn in drawing the Hour-lines, being careful to place it horizontal.

Then take the Thread fixed in the place of the Glafs, and draw it over any Azimuth which is desired to be drawn, and at the farther side of the Room fasten that Thread with a small Nail, as it was in drawing the reflected Hour-lines: Then take the Thread whose end is fastened in the said reflected Vertical-point, and bring that Thread so as just to touch the said Horizontal Thread, and augment it until the end thereof touch the Wall or Ceiling, and there make a Mark or Point. In like manner, move the said Thread whose end is fasten'd in the said Vertical-point, higher or lower at pleasure, till as formerly it touch the said Horizontal Thread, and mark again whereabouts the end thereof toucheth the said Wall or Ceiling: Now by help of these two Points found in the reflected Azimuth-line, the whole Azimuth-line may be drawn; for if (as before in drawing the Hour-lines) a Thread be so situated, that it may interpose between the Eye and the said two Points, you may make many Points at pleasure, to which the said Thread so situated may also interpose, which may be made at every Angle or bending of the Wall or Ceiling (as before) whereby the reflected Azimuth-line desired may be drawn. In like manner may the other reflected Azimuth-lines be drawn.

Also there may be Lines drawn parallel to the Horizon round about the Room, by help of the Thread fixed in the Centre of the Glafs, and a Quadrant for the Elevation thereof, which will shew the Sun's Altitude at any appearance thereof.

*Thus have I shewed the drawing of a reflected Dial from an horizontal Glafs, with all the usual Furniture thereon, though the Wall or Place on which it is to be drawn, be never so gibbous or irregular, or in what shape soever.*

Now the Glafs may be exactly situated Horizontal, if you draw a reflected Parallel for the present Day, and know also the true Hour, and so place the Glafs, that the Spot or Reflex of the Sun may fall thereon on the Ceiling, for there is no way by an Instrument to do it, the Glafs is so small.

2. If the Glafs be placed obliquely, and not parallel to the Horizon, it will recline with some Angle from the Zenith, and then to draw the reflected Dial true, these two Things are principally to be considered.

1. *The Reflected Horizon.*
2. *The Reflected Meridian.*

Note, the Horizon and Meridian are two great Circles.

1. *To draw the reflected Horizon according to the Situation of any reclining Glafs whatsoever.*

First, let two Pieces of nealed Wire be fastened on the Window on each side of the said Glafs, the Ends thereof being without the Room in the Air, at whose Ends let there be fastened a Thread which may be pulled straight at pleasure, by bending of the Wire; then bend those Wires upward or downward, until the Thread fastened at the End of each Wire be exactly Horizontal with the Centre of the Glafs, which may be tried by a Quadrant:

Then I tie a String or Thread cross the Room, in such a Sort, that I may from most part of the Thread see the reflecting Glafs, and therein the said horizontal Thread without the Room: Then on the said Thread cross the Room, I tie a slipping Knot to move to and fro at pleasure, which Knot I move to and fro on the said Thread, until by looking in the said Glafs I find from my Eye the said Knot and part of the Horizontal Thread without, all as it were in a right Line, the one interposing the sight of the other. Then being careful to keep the Knot in that position, fasten one End of a Thread in the place of the Centre of the reclining reflecting Glafs, and bring that Thread so, as just to touch the afore said Knot, augmenting that Thread, until the End thereof touch the Wall or Ceiling, and there make a Mark or Point; so is there one Point found on the Wall or Ceiling in the reflected Horizon of the World. Then I begin again, and remove the position of that Thread (which went overthwart the Room) either higher or lower at pleasure, still having regard that I may from the most part of the said Thread see the reflecting Glafs, and therein the same Horizontal Thread without the Room. Then, as before, I move the said Knot on the said Thread to and fro, until (as before) by looking in the said Glafs I find from my Eye the said Knot, and part of the Horizontal Thread, both in one right Line, the one interposing the sight of the other; and by the said Knot I bring the Thread, whose End is fastened in the Centre of the said Glafs, and keeping it just to touch the said Knot, I continue it, until the End thereof touch the Wall or Ceiling, as before, and there I make another Mark or Point; so is there two Points found in the said reflected Horizon on the Wall or Ceiling. By which said two Points, if a Thread (as before) be so situated, that it may interpose between the Eye and the said two Points, there may be many Points to be in the same Interposition of the Thread, which (as before) may be made at every bending or Angle of the Wall or Ceiling, whereby the reflected Horizon desired may be drawn, by drawing a Line from point to point round about the Room; which will be the true reflected Horizon according to the Situation of the Glafs.

2. *To draw the reflected Meridian, according to the Situation of any reclining Glafs whatsoever.*

First take a Lath or thin piece of Wood of any convenient Length at pleasure, as some one and an half, or two Foot long, and at each End thereof make a Hole, the one to hang a Thread or Plummet, and the other is to put a small Nail therein to fasten it in some part of the Window over the Centre of the Glafs, so that the Thread and Plummet may hang without the Room: Then by help of the Sun's Azimuth you may draw the Meridian-line, (as before) as if the Glafs were horizontal, and move the Lath with the Thread and Plummet at the End of it to and fro, until the Thread and Plummet be in the direct Meridian of the World with the Centre of the Glafs. Then, (as before) tie a Thread cross the Room, in such sort that from or by some part of the said Thread both the reclining Glafs and the Thread to which the Plummet is fastened may be seen at one Time. Then (as before) on the said Thread which crosses the Room, I tie a slipping Knot, which I move to and fro on the said String, until by looking in the said



faid Glafs I find from my Eye the faid Knot and fome part of the perpendicular Thread without, all as it were in one right Line, the one shadowing or interposing the fight of the other; being then very careful to keep that Knot in the fame Position, then take the Thread (the End whereof being fastned in the faid Centre of the Glafs) and bringing it just to touch the faid Knot, I augment that Thread, until the End thereof touch the faid Wall or Ceiling, and the faid Thread also touch the Knot, as before: Then in that place where the End of the faid Thread toucheth the Wall or Ceiling, I make a Mark, which Mark or Point will be directed in the reflected Meridian of the World, according to the Situation of that Glafs. Then again I remove that Thread, (overthwart the Room) on which the faid Knot is, either higher or lower than it formerly was, at pleasure, still having regard that from some part of the faid Thread within, you may see both the reclining Glafs and the perpendicular Thread without at one Time; and (as before) move the faid slipping Knot on the faid Thread, until by looking in the faid reclining Glafs, you see the faid Knot and some part of the perpendicular Thread without in one right Line, so as the one shadows or hinders the sight of the other, (as before) which Knot then must not be removed from its Situation; then take that Thread (whose End is fastened in the Glafs) and bring it to touch that Knot, the End of the faid Thread being continued to touch the Wall or Ceiling; so is that Point of Touch on the Ceiling another Point found in the reflected Meridian of the World. So is there two Points found in the faid reflected Meridian on the Wall or Ceiling; by which, if a Thread (as before) be so situated, that it may interpose between the Eye and the faid two Points, many Points thereby in the faid reflected Meridian may be made at every Bending or Angle of the Wall or Ceiling, whereby the reflected Meridian desired may be drawn, by drawing a Line from Point to Point obliquely in the Room, which will be the true reflected Meridian of the World, according to the Situation of that Glafs.

Now this reflected Horizon and Meridian being first drawn, they will be of great Use in drawing the Hour-Lines, together with all the Furniture that possibly can be drawn on any Dial.

*To draw the reflected Hour-Lines to any reclining Glafs on any Plane whatsoever, that the Sun will be reflected on: By help of an ordinary Horizontal Dial for that Latitude.*

First extend several Threads from the Centre of the Glafs to the Extremity of the reflected Horizon in the Room, (which for more Conveniency and Use may be the several Hour-lines, and may also serve as a Bed to situate the Horizontal Dial on the reflected Horizon) having regard to situate the Centre of the Dial on the Centre of the Glafs, and the Meridian of that Dial on the reflected Meridian of the World: Then to find the Point in the reflected reversed Axis on the Floor of the Room: Take a Thread, one End thereof being fastened in the Centre of the Glafs, and move the other End thereof to and fro in the reflected Meridian under the reflected Horizon, until by help of a Quadrant the faid Thread is found to be de-

pressed under the reflected Horizon, equal to the Latitude of the Place, and where the End of the faid Thread intersects or meets the reflected Meridian either on the Floor or Wall, that Point is the reflected reversed Axis, as was required. In which Point fasten one End of a Thread, which Thread will be of great Use in drawing the reflected Hour-lines on any Wall or Ceiling whatsoever. Now if this Thread, whose End is fastened in a Point on the reflected reversed Axis, be taken and brought to touch any part of any one of the Threads of the Hour-lines (produced to and fastened in the reflected Horizon) the faid Thread being continued so, as the End thereof may touch the Wall or Ceiling, and also any part of the faid Thread touch the Hour-line or Thread proposed; that Point on the Wall or Ceiling is in the reflected Hour-line desired to be drawn: Also the other Point in the same reflected Hour-line may be found; if the faid Thread, whose End is fastened in the reflected Axis, be brought to touch some other part of the same Hour-thread proposed; so that when (as before) the End of the faid Thread toucheth the Wall or Ceiling, some part of that Thread may also touch the Hour-line desired, which Point or Touch on the Wall or Ceiling, is also another Point in the faid reflected Hour-line desired. By which two Points so found (as before) the reflected Hour-line may be drawn by a Thread, projecting from those Points from the Eye, as it was formerly directed in drawing the reflected Hour-lines to an Horizontal Glafs.

*To draw the reflected Equinoctial Line, and also the Tropicks on any Wall or Ceiling, to any reclining reflecting Glafs.*

1. *To draw the reflected Equinoctial Line on the Wall or Ceiling.*

Take that Thread, whose End is fastened in the Centre of the reclining Glafs, and move the other End thereof to and fro in the faid reflected Meridian formerly drawn, until (by help of a Quadrant) the faid Thread is elevated above the reflected Horizon formerly drawn, equal to the Complement of the Latitude, (which as before will be always perpendicular to the reversed Axis) and make a Point in the faid reflected Meridian, where the End of the faid Thread toucheth; then on that Point and the faid reflected Meridian on the Ceiling, raise a perpendicular Line, which is the reflected Equinoctial Line desired.

2. *To draw the Reflected Tropicks, or other Parallels of Declination.*

First, (as before) make or take out of some Book or Table of the Sun's Altitude for each Hour of the Day, calculated for the Place of Latitude proposed, when the Sun is in either of the Tropicks, or other parallel of Declination: Then take that Thread, whose End is fastened in the centre of the Glafs, move the other End thereof to and fro in the Hour-Line proposed, until by applying one side of a Quadrant to the faid Thread, you find the faid Thread elevated above the reflected Horizon, answerable to the Sun's height in that Hour proposed, when he is in that Tropick or Degree of Declination proposed. Which Altitude required will be found in the 'foresaid Table for that End calculated, which faid Thread being of the



the Elevation above the reflected Horizon, as the said Table directeth: Then mark where the End of the Thread (so elevated) toucheth the Wall or Ceiling in that Hour-Line: So is one Point found in the reflected Parallel of Declination desired to be drawn. In like manner, find in the said Table in the same Parallel or Degree of Declination what Altitude the Sun hath at the next Hour, and elevate the said Thread, whose End is fastened in the centre of the Glass, equal to the Sun's Altitude in that Hour above the said reflected Horizon, by help of the said Quadrant, and where the other End of the said Thread falleth in the Hour-Line proposed, make another Mark or Point. And so, in like manner, make the Points (belonging to that Parallel of Declination) in the remaining Hour-Lines, according to the several Altitudes found in the said Table of Altitudes: Then drawing by hand a Line to pass through those several Points so found as before, which Line is the reflected Parallel of the Sun's Declination desired. In like manner may be drawn all or any other Parallel of Declination, which may have respect to the Sun's place, or the length of the Day, as shall be desired.

Or,

*To draw the said reflected Tropicks, or other Parallels of Declination, without any Tables calculated, only by help of a Trigon first made on Pastboard, or other Material. Note, That all Parallels are lesser Circles.*

First, (as formerly is shewed in drawing the Parallels of Declination to a reflecting Horizontal Glass) fasten the Trigon on the reflected reversed Axis, so that the centre of the Trigon may be in the centre of the Glass, then also will the Equinoctial on the Trigon be perpendicular to the said reflected reversed Axis: Then take the Thread fixed in the centre of the said Glass (which is also in the centre of the Trigon) and lay it upon that Parallel of Declination, drawn on the said Trigon, whose reflected Parallel is required to be drawn on the Plane or Ceiling: Then move the Trigon, the Thread lying on the said Parallel, until the End of the said Thread touch any Hour-Line on the said Wall or Ceiling, in which Point of Touch on that Hour-Line make a Mark, so will that Point be in the reflected Parallel of Declination desired. In like manner, move the said Trigon, still keeping the Thread on the same Parallel until the End of that Thread touch another Hour-Line on the said Plane or Ceiling, and there also make another Mark. And so in like manner find a Point in each Hour-Line, through which that reflected Parallel must pass; then drawing a Line to pass through those several Points on the said Plane or Ceiling, which Line is the reflected Parallel of the Sun's Declination desired.

In like manner may be drawn any other reflected Parallel of Declination required.

*To draw the reflected Azimuth-Lines to any Reclining Glass, or any Plane whatsoever that the Sun-beams will be reflected on. Here note, that Azimuths are great Circles.*

First, know that the reflected Vertical-point in the Axis of the reflected Horizon, will always be found in the reflected Meridian. And look how many Degrees the reflected Horizon differs from

the direct Horizon, so many must the reflected Axis of the Horizon differ from the direct Axis of the Horizon: Hence the reflected vertical Point, whereby the reflected Azimuth Lines are drawn, may be thus found.

Take that Thread whose End is fixed in the Centre of the Glass, and move the other End thereof to and fro in the reflected Meridian, until by applying one Side of a Quadrant thereto, you find the said Thread depressed just 90 Degrees, or perpendicular under the reflected Horizon; then make a Mark or Point where the other End of the said Thread toucheth the said reflected Meridian on the Wall, Ground or Floor of the Room, which Point so found, is the reflected Vertical Point desired, in which Point fasten one End of a Thread:

Then on Past-board or other Material draw the Points of the Compass or other Degrees, placing the Centre thereof in the Centre of the Glass, and the Meridian thereof in the reflected Meridian of the World, which said Past-board must be also situated in the reflected Horizon just as the Horizontal Dial was formerly directed to be situated for drawing the reflected Hour-Lines: And as the Threads from the Centre fastened in the reflected Horizon were also the Hour-Lines on the Horizontal Dial, whereby the reflected Hour-Lines were drawn: So now the Threads from the Centre fastened in the reflected Horizon may be the Horizontal Azimuth Lines, whereby the reflected Azimuth Lines may be drawn: Or if that Thread which is fastened in the Centre of the Glass be drawn exactly over any Azimuth Line, the End whereof being fastened by a Nail or other Means in the reflected Horizon on the other Side of the Room, there may several Points be found in the Wall or Ceiling, through which the reflected Azimuth Line must pass, as followeth:

Take that Thread, one End of which is fastened in the said Vertical Point, and bring it just to touch the Azimuth-Thread formerly fastened, and continue it until the End thereof touch the Wall or Ceiling, (and also the Thread it self touch the said Azimuth it self, as before) in which Point of Touch on the Wall or Ceiling make a Mark, thro' which Point that reflected Azimuth Line must pass. Then move the said String fastened in the said Vertical Point, so that it may just touch the said Thread again, but in another place: Then, as before, continue that Thread until the End thereof touch the Wall or Ceiling again, as before, and there make another Mark, through which the said reflected Azimuth Line must also pass: In like manner may more Points be found for your further Guide, in drawing that Azimuth Line: But two Points being found will be sufficient.

*To draw any reflected Line by any two Points given over any Plane whatsoever, without projecting, by the Eye.*

Fasten two Threads in the place of the Centre of the said reclining Glass, drawing the said Threads strait, fastening each of the other Ends in the two reflected Azimuth Points formerly found on the Wall or Ceiling. Then situate a Thread cross or thwart the Room, so as it may cross those other Threads from the Centre, near at right Angles, and also just touch both of them in that Situation. By which said Thread cross the Room may any Number of Points in the said reflected Azimuth



Azimuth Line to be drawn, be found at pleasure: For if the End of another Thread be also fastened in the Centre of the said Glass, making the other End thereof to touch the Wall or Ceiling, but so that it may also just touch the said Thread, which is fastened cross the Room, which Point of Touch on the said Wall or Ceiling is another Point in the said reflected Azimuth Line required to be drawn. In like manner may more Points be found at every Angle or Bending of the Wall or Ceiling for the exacter drawing the reflected Azimuth Line required, which doth find Points, whereby is drawn the same reflected Azimuth Line, (or other Lines) as was formerly done by a Thread so situated, that it may interpose between the Eye and any two Points assigned on the Wall or Ceiling.

In like manner, if the Thread fastened on the further Side of the Room were removed to another Azimuth Line on the said Past-board, and then fasten it again on the further Side of the Room, (as before) you may by help of the said Thread, fastened in the said Vertical Point, find several Points on the Wall or Ceiling, thro' which that Azimuth Line will pass: So may you either by this or the former way draw what Azimuth Lines you please, either in Points of the Mariner's Compass or Degrees, as you please, by drawing it first on Past-board, as before is directed.

And note generally, that such Relation the Point found on the Floor or Ground in the reflected reversed Axis, hath to the Hour-Line drawn on the Horizontal Dial, in drawing the reflected Hour-lines: The same hath the reflected Vertical-point found on the Floor or Ground, to the Azimuths drawn on the Past-board in the drawing the reflected Azimuth-lines.

*To draw the reflected Parallels of the Sun's Altitude, or Proportions of Shadows to any reclining Glass on any Plane whatsoever, that the Sun-beams be reflected on. Here note, That Parallel's of Altitude are lesser Circles, therefore are not represented by a Right-line.*

First, Know generally that what respect the Parallels of Declination have to Hour-lines, such have the Parallels of Altitude to the Azimuths.

For if one End of a Thread be fastened in the Place of the Centre of the reclining Glass, and the other End moved to and fro in any reflected Azimuth Line, until the said Thread be elevated any Number of Degrees proposed above the reflected Horizon (the Elevation of which Thread being found, by applying a Quadrant thereto) and making a Mark or Point where the End of the said Thread toucheth the said reflected Azimuth drawn on the Wall or Ceiling, that Point so found is the Point through which that Almicanter or reflected Parallel of the Sun's Altitude must pass.

In like manner, remove the other End of the said Thread fastened in the Centre of the Glass to another reflected Azimuth Line, and (as before) move it higher or lower, until by applying the Edge of a Quadrant to that Thread, you find the said Thread above the reflected Horizon on the same Number of Degrees first proposed, and at the End of the said Thread in that reflected Azimuth Line drawn on the Wall or Ceiling, I make another Mark or Point, through which the same reflected Almicanter or Parallel of Altitude must also pass: And so in like manner I find a Point on each reflected Azimuth Line, through which the

same Parallel of Altitude must pass. Then drawing by hand a Line to pass through these several Points so found, (as before) that Line is the reflected Parallel of the Sun's Altitude proposed. In like manner may be drawn all the other Parallels of Altitude desired, which will shew the Sun's Altitude or the Proportion of any Shadow to its Altitude, at any Appearance of the Sun's Reflection thereon.

*To draw the Jewish or old Unequal Hour Lines to any reclining Glass on any Plane whatsoever that the Sun-beams will be reflected on. Here note, that the Jewish Hour Lines are great Circles.*

First (by the Rules formerly given) draw two reflected Parallels of Declination of 16 deg. 55', the one being near the Summer, and the other near the Winter Tropicks: For when the Sun hath that Declination, the Day is 15 Hours long in the Summer, and 9 in the Winter: Then (as is formerly directed) situate a Thread just between the Eye and those three Points in the said reflected Dial, as is expressed in the ensuing Table, so may you thereby draw all or any of those Jewish Hour Lines desired, which will at any Appearance of the Spot by the Reflex of the Glass amongst those Hour Lines, shew how many of the equal Hours is past since Sun-rising, as was desired. Now in this Latitude of 51 deg. 30'. If the Parallels of the Sun's Declination be drawn, both when the Day is 9 and 15 Hours long, that is, when it is 16 deg. 55', any of those Jewish Hour Lines will intersect the common Hour Lines, either upon the Hours, Half-hours, or Quarters. And such a Declination may be found, that it shall do so in any Latitude desired.

| Uneq.<br>Hours. | 15<br>H. M. | Equal<br>Hours. | 9<br>H. M. |
|-----------------|-------------|-----------------|------------|
| 0               | 4 30        | 6               | 7 30       |
| 1               | 4 45        | 7               | 8 15       |
| 2               | 7 00        | 8               | 9 00       |
| 3               | 8 15        | 9               | 9 45       |
| 4               | 9 30        | 10              | 10 30      |
| 5               | 10 45       | 11              | 11 15      |
| 6               | 12 00       | 12              | 12 00      |
| 7               | 1 15        | 1               | 0 45       |
| 8               | 2 30        | 2               | 1 30       |
| 9               | 3 45        | 3               | 2 15       |
| 10              | 5 00        | 4               | 3 00       |
| 11              | 6 15        | 5               | 3 45       |
| 12              | 7 30        | 6               | 4 30       |

REFLECTED Ray, or Ray of Reflection, is that whereby the Reflection is made upon the Surface of a reflecting Body.

REFLECT, <sup>2</sup> [in Painting] signifies those Pla-

REFLEX, <sup>3</sup> ces in a Picture which are supposed to be illuminated by a Light reflected from some other Body that is represented in the same Piece.

REFLECTION, in general, is the regress or return that happens to a moving Body, because of the meeting of another Body, which it cannot penetrate. Thus the material Rays of Light are reflected variously from such Bodies as they cannot pass through.



**REFLECTION** [in *Metaphysics*] Mr. *Lock* defines to be, That Notice which the Mind takes of its own Operations, and the manner of them; by reason whereof there come to be Ideas of those Operations in the Understanding.

**REFLECTION** of the Rays of Light. Sir *Isaac Newton*, finding by Experiment that Light was an heterogeneous Body, consisting of a mixture of differently refrangible Rays; and consequently concluding no farther Improvement could well be made in Optical Instruments in the Dioptrick way, he took *Reflections* into Consideration, and tells us, that by their help, Optick Instruments might be brought to *any degree of Perfection*, if we could but find a reflecting Substance which would Polish as finely as Glass, reflect as much Light as Glass transmits, and be formed into a Parabolical Figure.

An Experiment of which he made in the kind of a Catoptrick Telescope (which I have seen at *Gresham College*) and by which, tho' not above two Feet long, he could (he saith) discern the Jovial Satellites, and the Phases of *Venus*. *Phil. Trans.* N. 18.

**REFLECTING**, or *Reflective Dials*, are made by a little piece of Looking-Glass-Plate, duly placed, which reflects the Sun's Rays to the top of a Ceiling, &c. where the Dial is drawn. This Glass should be as thin as can well be ground. For the making of these Dials there are many Methods: Of the two following the 1st is Mr. *Collins's*, the 2d Dr. *Clark's*.

*First*, Determine the most convenient Point in the Window, where to place the *Reflecting Glass*, as near the Ceiling as you can conveniently, provided it be not so near as that the Cornish of the Window will shade the Glass when the Sun is high in Summer; suppose within about 10 or 11 Inches of the Ceiling, at least of that Ceiling which belongs to the Window itself; then from that Point draw a true Meridian upon a plane Horizontally placed against the determined Point in the Window, and to that Meridian fit an Horizontal Dial; but invert it so, that the Axis or Stile may point downward, and be under the Horizontal Plane, according to the Elevation of the Pole, which Stile must be placed truly also in the Plane of the Meridian; then by the help of a Thread running from the Centre along the Stile, find where that Stile would cut the Floor, or any other Place, if it were produced, and drive a Nail into that Point, and fasten also a Thread there long enough to be extended to any part of the Ceiling.

Fasten also another long Thread to the Centre of the Horizontal Dial, which let it be extended horizontally, as the Plane will direct, and exactly over every Hour-Line in order, whilst in the mean time you extend the Thread which was fastened to the Nail in the Stile, to the Ceiling, but so as it may touch the other Horizontal Thread: Then mark that Point in the Ceiling which the extended Thread toucheth, and make more such Marks, whereby to draw the Hour-Lines upon the Ceiling; and do this in like manner for the rest of the Hours, Half-hours, and Quarters.

Then take all away, and place your Glass horizontally; and because your Glass hath some Thickness, place it a little under the determined Point, that the Centre of the Glass may be just in the imaginary Axis, which goes to the Nail; for wheresoever you place it, in that it will go true.

But because it may be troublesome to place an Horizontal Dial fast enough and exactly, as also to find the Point where the Nail is to be driven, I will shew you another Method, which may be more easily practised.

*First*, Draw an Horizontal Dial upon the back of some Table or Floor, and draw a Meridian upon the Bay-board of the Window, by a Thread or perpendicular black Line, passing through the Point where you intend your reflecting Glass shall be, and by a Plumb-Line translate it from the Bay-board to the Ceiling. Take the nearest Distance between the Glass and the Ceiling; with this Distance come to the Horizontal Dial, and set one End of it on that Part of the Axis where the other will just touch the Meridian; that Point in the Axis may be called the Glass Point; from which erect a Perpendicular; and where it cuts the Meridian, make a Point, which will be the Equinoctial Point, from which also erect a Perpendicular, which will be a Tangent; then at some Distance on which Side of the Equinoctial Point you find most convenient, erect another Tangent there, two Tangents will cut the Hour-Lines in Points, which may be called the Hour-Points.

Then take the Distance betwixt the Glass Points and the Equinoctial Point, and extend it from the Glass toward the Meridian, and where it toucheth, that is the Equinoctial Point upon the Ceiling.

*Lastly*, Set off correspondent Tangent Lines upon the Ceiling, and make like Hour Points, draw the Hour-Lines, you need not blot out the Equinoctial Tangent, it being pleasant to see how the Sun will go in that Line all Day, when it is in the Equinoctial. Besides, the Equinoctial Point will tell you on that Day whether your Glass lie horizontally, which is somewhat difficult otherwise to determine. Or upon any Day you may calculate the Sun's Meridian Altitude, and see whether it falls just upon that Point in the Meridian at 12 a Clock.

This Dial is nothing but an Horizontal inverted, the Centre whereof is in the Air without, except you make a North Dial, and then it will be upon the Ceiling, which you must find by its Distance from the Equinoctial Point, and let that Centre govern your Tangents. The Ground of this Dial is, that the Angles of Reflection are equal to the Angles of Incidence.

Sometimes, instead of two Tangents, you may use two Circles, especially when the Centre of the Dial is upon the Ceiling, or when your Glass is near the Window Ceiling, then the Equinoctial Point will be upon that Ceiling, and you may project the Hour-Lines upon the Chamber Ceiling, or the Walls, by one Thread extended over the Hour-Lines, and another Thread touching that, and extended from the Equinoctial Point, or any Point in the imaginary Axis to the Ceiling or Wall.

**REFLECTING Telescope**: See *Telescope*.

**REFLEXION** of the Moon, is (according to *Bullialdus*) her third Inequality of Motion: This *Tycho* calls by the Name of her *Variation*; which see.

**REFLECTION** is a Power the Human Mind hath of perceiving its own Operations, within it self, when it is employed about the Ideas it hath before gotten by Sensation; which Operations, when we come to reflect and consider on them, do furnish our Understanding with a great Number of Ideas, which could not be had by bare Sensation, of Things without us: Such as *Perception, Thinking, Believing, Doubting, Reasoning, Knowing,*



ing, Willing, &c. and all the differing Actions of the Mind.

**REFLECTION** of the Rays of Light, [in Opticks,] is a Motion of the Rays, whereby (after impinging on the solid Parts of Bodies, or rather, after a very near Approach thereto) they recede, or are driven therefrom.

The *Reflection of the Rays of Light* from the Surface of Bodies, is the means whereby they become visible; and the Disposition of Bodies to *reflect* this or that kind of Rays most copiously, is the Cause of their being of this or that Colour: The *Reflection of Light* from the Surfaces of Mirrors, make the Subject of *Catoptricks*.

The *Reflection of Light*, Sir Isaac has shewn, is not effected by the Rays striking on the very Parts of the Bodies, but by some Power of the Body equally diffus'd throughout its whole Surface, whereby it acts upon the Ray, by attracting or repelling it without any immediate Contact.

This Power he shews to be the same whereby (in other Circumstances) the Rays are refracted, and whereby they are at first emitted from the lucid Body.

The Arguments he produces to this Purpose, are as follow.

1. Because the Surfaces of polished Glasses, which to the Eye appear smooth, are yet in Reality very rugged and uneven; (polishing being nothing but the grating, scratching, and breaking off the coarser Protuberances, by means of Sand, Glass, Putty or Tripoly) if the Rays of Light, therefore, were *reflected* by striking on the solid Parts of the Glass, the *Reflections* would never be so accurate as we find they are; but the Rays would even be as much scattered by the most polished Glass, as by the roughest. It remains (therefore) a *Problem*, how Glass polished by fretting Substances, can *reflect* Light so regularly as it does; which *Problem* is scarce otherwise to be solved, than by saying, that the *Reflection* of a Ray is effected, not by a single Point of the *reflecting* Body, but by some Power of the whole Body, evenly diffused all over its Surface, and by which it acts on a Ray without immediate Contact; for that the Parts of Bodies do act upon a Light at a Distance.

2. If the Colours separated by a Prism placed at the Entrance of a Beam of Light into a darkened Room, be successively cast on a second Prism placed at a greater Distance from the former, in such manner as that they all fall alike, or with an equal Obliquity upon it, the second Prism may be so inclined to the incident Rays, that those which are of a blue Colour shall be all *reflected* by it, and yet those of a red Colour, pretty copiously transmitted. Now, if the *Reflection* were caused by the Parts of the Air or Glass, we would ask, why (at the same Obliquity of Incidence) the blue should wholly impinge on those Parts so as to be all *reflected*, and yet the red fine Pores enough to be in a great measure transmitted?

3. Where two Glasses touch one another, there is no sensible *Reflection*; and yet we see no Reason why the Rays should not impinge on the Parts of the Glass, as much when contiguous to other Glass, as when contiguous to Air.

4. When the Top of a Water Bubble, by the continual subsiding and exhaling of the Water, grows very thin, there is such a little (and almost insensible) Quantity of Light *reflected* from it, that it appears intensely black; whereas round

about that black Spot, where the Water is thicker, the *Reflection* is so strong, as to make the Water seem very white. Nor is it only at the least Thickness of thin Plates or Bubbles, that there is no manifest *Reflection*, but at many other Thicknesses, gradually greater and greater: For, in one of our Author's Observations, the Rays of the same Colour were by turns transmitted at one Thickness, and *reflected* at another Thickness, for an indeterminate Number of Successions: And yet in the Superficies of the thinned Body, where it is of one Thickness, there are as many other Parts for Rays to impinge on, as where it is of any other Thickness.

5. If red and blue Rays (separated by a Prism) fall successively on a thin Plate of any pellucid Matter, whose Thickness increases in continual Proportion, (such as a Plate of Air between two Glasses, the one plane, and the other a little convex) the same Plate will (in the same part) *reflect* all the Rays of one Colour, and transmit all those of the other; but in different Parts will *reflect* the Rays of one and the same Colour at one Thickness, and transmit them at another; and thus alternately, and *in infinitum*. Now it can never be imagin'd that at one Place the Rays which (for Instance) exhibit a blue Colour, should have the Fortune to strike on the solid Parts, and those which exhibit a red, to hit on the void Parts of the Body; and at another Place, where the Body is either a little thicker, or a little thinner, that on the contrary, the blue should hit on the Pores, and the red upon the solid Parts.

6. In the Passage of Light out of Glass into Air, there is a *Reflection* as strong, as in its Passage out of Air into Glass, or rather a little stronger; and by many Degrees stronger than in its Passage out of Glass into Water.

Now it seems improbable that Air should have more *reflecting* Parts than Water or Glass: But if that should be supposed, yet it will avail nothing; for the *Reflection* is as strong, or stronger, when the Air is drawn from the Glass by the Air Pump, as when it is adjacent to it. If any should here object, on *Des Cartes* Hypothesis, that though the Air be drawn out, there is a subtle Matter remaining to supply its Place, which being of a denser kind, is better fitted for the *Reflection* of Light than any other Body: Besides, that we have elsewhere shewn, such subtle Matter to be fictitious; and that supposing its Existence, and its *reflecting* power, no Light could ever have been propagated, but must have all been *reflected* back to the lucid Body, immediately after it was first emitted: The following Experiment does evidently convict it of Falsity.

7. If Light in its passage out of Glass into Air strike more obliquely than at an Angle of 40 or 41 Degrees, it is wholly *reflected*; if less obliquely, it is in great measure transmitted. Now it is not to be imagin'd, that Light at one Degree of Obliquity should meet with pores enough in the Air to transmit the greater part of it, and at another Degree should meet with nothing but parts to *reflect* it wholly; especially considering that in its passage out of Air into Glass, how oblique soever be its Incidence, it finds pores enough in the Glass to transmit a great part of it. If any suppose that it is not *reflected* by the Air, but by the outmost superficial parts of the Glass, there is still the same Difficulty: Besides, that such a Supposition is unintelligible, and will also appear to be



be false, by applying Water behind some part of the Glass, instead of Air; for so, in a convenient Obliquity of the Rays, suppose of 45 or 46 Degrees, at which they are all reflected, where the Air is adjacent to the Glass, they shall be in great measure transmitted where the Water is adjacent to it; which argues, that their *Reflection* or *Transmission* depends on the Constitution of the Air and Water behind the Glass, and not on the striking the Rays upon the Parts of the Glass; the Rays not being *reflected* till they have reached the last part of the Surface, and are begun to go out: For if in going out they fall upon the Surface of Oil or Water, they proceed, the Attraction of the Glass being balanced by an equal Force the contrary way, and prevented from having its Effect by the Attraction of the Liquor adhering to it; but if the Rays in passing out of this last Surface fall into a *Vacuum* which has no Attraction, or into Air which has but little, (not enough to counterbalance the Effect of the Glass) in this Case the Attraction of the Glass draws them back, and *reflects* them: This will appear still more evident, by laying two Glass Prisms, or the Object Glasses of two Telescopes, the one plane, and the other a little convex, upon each other, so as they may neither touch, nor yet be too far a-part; for that Light which falls on the hind Surface of the first Glass, where the Glasses are not above  $\frac{1}{1000}$  part of an Inch, a part will be transmitted through the Surface, and through the Air or *Vacuum* between the Glasses, and pass into the second Glass; but if the second Glass be taken away, then the Light passing out of the second Surface of the first Glass into the Air or *Vacuum*, will not proceed, but return into the first Glass, and be *reflected*.

Whence it follows, that the Rays are drawn back again by some Force in the first Glass; there being nothing else to occasion their return. And hence too it follows, that the *Reflection* is not effected by means of any subtle Matter, contiguous to the hind Surface, according to the Principles of *Des Cartes*, since that Matter ought to *reflect* them when the Glasses were nearly contiguous, as well as when the second Glass is removed.

*Lastly*, If it be ask'd, how some of the Rays come to be *reflected*, and others transmitted? And why they are not all alike *reflected*? supposing the *Reflection* owing to the Action of the whole Surface; the same great Author shews, that there are both in the Rays of Light, and in the Bodies themselves, certain Vibrations (or some such Property) impressed on the Rays, by the Action either of the Luminary that emits them, or of the Bodies that *reflect* them; by means whereof it happens that those Rays in that part of their Vibration, which conspires with the Motion of the Parts of the Body, enter the Body, are refracted and transmitted; but those in a contrary part of their Vibration, *reflected*.

Add, that every Ray of Light, in its Passage through any refracting Surface, is put into a certain transient Constitution or State, which in the Progress of the Ray returns at equal Intervals, and disposes the Ray at each return to be easily transmitted through the next refracting Surface; and between each Return to be easily *reflected* by it.

These alternate Dispositions, which Sir *Isaac Newton* calls *Fits of easy Reflection*, and of *easy Transmission*, he accounts for, by supposing that the Rays of Light, in impinging on Bodies, excite Vibrations therein; which happening to move

faster than the Rays, when a Ray is in that part of the Vibration which conspires with its Motion, it passes through; but when on the contrary part of the Vibration, is beat back again; whence every Ray is successively disposed to be easily *reflected*, or easily transmitted, by every Vibration which overtakes it.

REFLECTION [in *Catoptricks*] is the Return of a Ray of Light from the polished Surface of a Speculum or Mirrour, driven thence by some Power residing therein.

The Ray thus returned is called a *Reflex*, or *reflected Ray*, or Ray of *Reflection*; and the Point of the Speculum, whence the return commences, the Point of *Reflection*.

Thus the Ray A B, (See Fig. 1.) proceeding from the Radiant A, and striking on the Point of the Speculum B, being returned thence to C; B C represents the *reflected Ray*, and B the Point of *Reflection*; in respect whereof A B represents the incident Ray, or Ray of Incidence, and B the Point of Incidence.

Again, a Line, as C G, drawn from any Point, as C, of the *reflected Ray* B C, perpendicular to the Speculum, is call'd the *Cathetus* of the *Reflection*, or *Cathetus* of the Eye; as a Line, A F, drawn from the Radiant, perpendicular to the Speculum, is called the *Cathetus* of Incidence.

Of the two Angles which the *reflected Ray* B C makes with the Mirrour, the smallest, C B E, is called the Angle of *Reflection*; as, of the two Angles the incident Ray makes with the Speculum, the smallest, A B D, is called the Angle of Incidence.

If the Mirrour be either concave or convex, the smallest Angles the Ray makes with a Tangent to the Point of *Reflection* and Incidence, are the Angles of *Reflection* and Incidence.

The Angle, C B H, which the *reflected Ray* makes with a Perpendicular to the Point of *Reflection*, is called the Inclination of the *reflected Rays*; as the Angle A B H is called the Inclination of the incident Ray.

#### The general Laws of Reflection.

1. If a Ray of Light be *reflected* from a Speculum of any Form, the Angle of Incidence is ever equal to the Angle of *Reflection*. This Law obtains in Percussions of all Kinds of Bodies, and consequently must do so in those of Light.

It might therefore be here assum'd as an Axiom; but 'tis of that Importance, and its Demonstration so beautiful, that we cannot omit it. Suppose then, D C an incident Ray, propagated from the Radiant A: Here, though the Motion of the Ray be simple, yet its Determination in the Line D C being oblique with respect to the Obstacle, is really compounded of two Determinations; the one along D E, the other along D G.

The Force along D C, therefore is equal to the two Forces along D G and D H; but the Obstacle G F only opposes one of the Determinations, viz. that along D G; (for it cannot oppose a Determination parallel to it self, as D E;) therefore only the Force along D G will be lost by the Stroke; that along D H or G C remaining entire. But a Body perfectly elastick, (such as we suppose the Ray of Light) will recover by its Elasticity, the Force it lost by the Shock.

The Ray therefore will recover the Force D G or C H: Thus, retaining both its Forces, and both



its former Determinations,  $HC$  and  $CF$ , after Percussion, it will be impell'd along  $CF$  and  $CH$ , by the same Forces as before along  $DH$  and  $DG$ , by its compound Motion, therefore it will describe the right Line  $CE$ , and that in the same time as  $DC$ ; and  $HE$  and  $DH$  will be equal, as being described by the same Force. Now, the two Triangles  $DCH$  and  $CHE$  are equal, and consequently their similar Angles equal; since then,  $HCA = HCF$ ;  $DCA$  the Angle of Incidence, is equal to  $ECF$  the Angle of Reflexion. *Q. E. D.*

This Law is confirmed in Light by an easy Experiment; for the Ray of the Sun falling on a Mirror in a dark room, thro' a little Hole; you'll have the pleasure to see it rebound, so as to make the Angle of Reflexion equal to that of Incidence.

The same may be shewn various other ways: Thus, *e. gr.* Placing a Semicircle  $FIG$  (See *Fig. 2.*) on a Mirror,  $DE$ , its Centre on  $B$ , and its Limb perpendicular to the Speculum; and assuming equal Arches,  $Fa$  and  $Gc$ , place an Object in  $A$ , and the Eye in  $C$ , then will the Object be seen by a Ray reflected from the Point  $B$ , and if  $B$  be cover'd, the Object will cease to be seen.

Hence, *i.* If a Ray of Light, as  $HB$ , fall perpendicularly on the Surface of a Speculum  $DE$ , it will be reflected back upon it.

*2.* From the same Point of a Speculum several Rays cannot be reflected to the same Point; for in that Case all the several Angles of Reflexion would be equal to the same Angle of Incidence, which is absurd.

*3.* One Ray, as  $AB$ , cannot be reflected to two or more Points; for in that Case all its Angles of Reflexion would be equal to the same Angle of Incidence; which is as absurd as before.

*2d.* Each Point of a Speculum reflects Rays falling on it from each part of an Object.

Hence, since several Rays coming from several parts of a radiant Object, cannot be reflected from the same Point of a Speculum to the same Point; the Rays that flow from different points of the Object are separate after Reflexion: And hence, each Ray shews the Point whence it proceeded. On this Principle it is, that the Rays reflected from Mirrors or Looking-glasses, exhibit the appearances of Objects placed before them.

And hence we easily conceive, why rough Bodies exhibit no Images, in regard they reflect the Light in such manner as to confound Rays which proceed from different Points, by means of their Eminencies and Cavities, their alternate Risings and Fallings: But for this, all hard Bodies would be Mirrors.

*3d.* If the Eye  $C$ , and the radiant Point  $A$  change places, the Point will continue to radiate upon the Eye, in the same Course or Path as before.

For if the Object be removed from  $A$  to  $C$ , it will still radiate on its former Point of Reflexion  $B$ , but there can be but one Right-line drawn between the two Points  $C$  and  $D$ ; and the Rays are Right-lines, therefore that which was before the Ray of Reflexion, will now be the Ray of Incidence; and since it will be reflected under the same Angle, as that under which it fell, that which was before the Ray of Incidence, will now be the Ray of Reflexion; so that the Object removed to  $C$ , will radiate on the Eye placed in  $A$ , by the Right-lines  $CB$  and  $BA$ . *Q. e. d.*

Hence, an Object is seen by the reflected Ray

$AB$ , with the Eye placed in  $A$ , the same as if the Eye were in  $AC$ , and the Object in  $A$ .

The Truth of this Theorem is so easily confirm'd by Experiment, that some, with *Euclid*, assume it as a Principle, and demonstrate the great Law of Reflexion therefrom: — Thus, Suppose the Angle of Incidence a little greater than the Angle of Reflexion, then will the Angle  $ABF$  be greater than that  $CBE$ ; wherefore changing the places of the Eye and the Object, the Angle  $CBE$  will become the Angle of Incidence; and therefore  $CBE$  greater than  $ABF$ , by the Supposition; so that the same Angle  $ABF$  will be greater and smaller than the other  $CBE$ ; which being absurd,  $ABE$  cannot be greater than  $CBE$ . The same Absurdity will follow, if you suppose the Angle of Incidence less than the Angle of Reflexion; Since then the Angle of Incidence can neither be greater nor less than that of Reflexion, it must be equal to it.

*4th.* The Plane of Reflexion, that is, the Plane wherein the Incident and reflected Ray are found, is perpendicular to the Surface of the Speculum; and in spherical Specula passes thro' the Centre.

Hence, the Cathetus both of Incidence and Reflexion is in the Plane of Reflexion.

That the Plane of Reflexion is perpendicular to the Speculum, is assum'd by *Euclid*, *Alhazen*, and others, as a Principle without any Demonstration, as being evident from all Observation and Experiment.

*5th.* The Image of an Object seen in a Mirror, is in the Cathetus of Incidence.

This the Antients assumed as a Principle; and hence, since the Image is certainly in the reflected Ray, they infer'd, it must appear in the Point of Concourse of the reflected Ray, with the Cathetus of Incidence; which indeed holds universally in plane and spherical Mirrors, and usually in concave ones, a few Instances only excepted; as is shewn by *Kepler*, for the particular Laws of Reflexion, arising from the Circumstances of the several kinds of Specula, or Mirror, Plane, Concave, Convex, &c.

REFLECTION, in the *Pythagorean* or *Copernican* System, is the Distance of the Pole from the Horizon of the Disk; which is the same thing as the Sun's Declination in the *Ptolemaick* Hypothesis.

REFLEXIBILITY of the Rays of Light, is their Disposition to be turned back into the same Medium, from any other Medium on whose Surface they fall; and therefore those Rays are more or less reflexible, which are returned back more or less easily.

As if Light pass out of Glass into Air, and by being enclined more and more to the common Surface of the Glass and Air, begins at length to be totally reflected by that Surface; those Sorts of Rays which are like Incidences are reflected most copiously; or by inclining the Rays begin soonest to be totally reflected, are most reflexible. *Newton's Opticks*, p. 2.

There is the same constant Relation between Colour and Reflexibility: Light of a Violet Colour being in like Circumstances reflected at least Thickness of any Plate or Bubble; (see *Obs.* 13, 14, and 15, compared with 4 or 18th) The red Rays at the greatest Thicknesses; and the intermediate Colours at intermediate Thicknesses: So that the coloretick Properties of the Rays must be connate with them, and immutable.



**REFLEX Vision** } is that which is per-  
**REFLECTED Vision** } formed by means of  
 Rays reflected from the polished Surfaces of Ob-  
 jects to the Eye.

**REFLUX** of the Sea, is the *Ebbing* of the Wa-  
 ter off from the Shore; as its coming on upon it,  
 or Tide of Flood, is called the Flux of the Sea.  
 See *Tide*.

**REFORM**, to *reform* in a *Military* Sense is to  
 reduce a Body of Men either by disbanding the  
 Whole, or only breaking a Part, and retaining  
 the rest, or sometimes by incorporating them in  
 other Regiments. So that a

**REFORMED Officer** is one whose Troop or  
 Company is broke, and he continued in either  
 whole or half Pay, doing Duty in the Regiment.

**REFRACTED Angle**, [in *Opticks*] is the Angle  
 contained between the refracted Ray and the per-  
 pendicular.

**REFRACTED Dials** are such as shew the true  
 Hour only, by the means of some refracting  
 transparent Fluid: As thus,

If you stick up a Pin or Stick, or assign any  
 Point in any Concave, Bowl, or Dish, to shew the  
 Hour, and make that the centre of your hori-  
 zontal Dial; (See *Reflected Dialling*) assigning  
 the meridian Line on the Edges of the Bowl, point  
 out the rest of the Hour-lines also on the Edges of  
 the Bowl, and taking away the horizontal Dial,  
 elevate a String, or Thread, from the End of the  
 said Pin fastened thereto over the Meridian Line,  
 equal to the Latitude or elevation of the Pole of  
 the Place: Then with a Candle, or by bringing  
 the Thread to cast a Shadow on any Hour-point  
 formerly mark'd out on the Edges of the Bowl,  
 that Shade in the Bowl is the true Hour-line;  
 and if the Bowl be full of Water, &c. When this  
 is done, it will never shew the true Hour by the  
 Shadow of the top of the Pin, but when filled  
 again with the same Liquor.

**REFRACTION** in general, is the Incurvation  
 or change of Determination in the Body moved,  
 which happens to it whilst it enters or penetrates  
 any *Medium*.

In *Dioptricks*, it is the variation of a Ray of  
 Light, from that right Line which it would have  
 passed on in, had not the density of the Medium  
 turned it aside.

Dr. Hook discovered by Experiment, That the  
*Sines* of the Angles of Incidence of the Rays of  
 Light, are proportionable to the *Sines* of Refraction.  
 See the Preface to *Micrographia*, where his Instru-  
 ment is described, by which he made the Disco-  
 very.

Sir Isaac Newton found that the Rays of Light  
 are Incurvated or Refracted in their Motion, when-  
 ever they come near the Edges of any Body, tho'  
 it be not Diaphanous. See *Light*.

And he thinks that the Errors of Refraction in  
 Optick Glasses might be corrected, if two Spherical  
 Glasses were combined together with Water inclu-  
 ded between them. And such Glasses he judges  
 preferable to elliptical or hyperbolic ones, be-  
 cause (besides that they can be more easily ground)  
 they do more accurately refract the Pencils of Rays  
 posited without the Axis of the Glas.

Dr. Wallis in *Philos. Trans.* N. 187. saith, That  
 tho' Refraction by Vapours near the Horizon, may  
 make a thing appear higher, yet it cannot make it  
 appear broader; whereas in Refraction by Glasses,  
 the thing is apparently enlarged every way.

From whence it is, that the diverse Power of

Refraction in Fluids arises, is not easy to deter-  
 mine, tho' it would be of great Advantage if it  
 could be discovered: Pure clear Water, of all Flu-  
 ids, refracts the Rays of Light the least; and if it  
 be impregnated with Salts, it encreases the Refra-  
 ction in proportion to the Quantity and Weight of  
 the Salts dissolved in it.

The *Aqua Stygia*, or corrosive Menstruums  
 such as *Aqua fortis*, &c. which are Salt dissolved  
 and rendred Corrosive by the violence of the Fire,  
 do yet much more refract the Sun's Rays; which  
 need not be wondred at, because these are much  
 denser and heavier Fluids than the former. But  
 then why in such light fine Fluids as Spirits of  
 Wine, and other ardent Spirits; in Oil of Tur-  
 pentine, which is so light and fine a Fluid, as to  
 be generally called an *Ethereal Oil*; why these, I  
 say, should produce so great a degree of *Refraction*,  
 as 'tis known they do, is a thing of great Diffi-  
 culty to account for, and well deserves a farther  
 Enquiry into.

Dr. Gregory, in his *Astronomy*, very well accounts  
 for the Oval Figures which the Sun near the Hori-  
 zon (especially in high Latitudes) is sometimes  
 seen to put on from *Refraction*. For having be-  
 fore demonstrated, That because of the Earth's  
 Atmosphere, all Bodies near the Horizon will ap-  
 pear something higher in the vertical Circle than  
 they really are, and this the more, the nearer  
 they are to the Horizon: He shews that the upper  
 Margin of the Sun's Disk being raised a little more  
 than it ought to be, and the lower one a great deal  
 more, the Sun's vertical Diameter will seem to be  
 contracted, but the Horizontal one will not, and  
 therefore he will appear Oval. And for the same  
 Reason, the observed Distance of two Fix'd Stars,  
 is sensibly less (when measured by an Instrument)  
 if they are in the same vertical Circle, and one of  
 them near the Horizon, than when they both have  
 a considerable Altitude.

After this he shews how to determine the Quan-  
 tity of the *Refraction* in any given Degree of Alti-  
 tude, and to make a Table of it: thus,

Let some Fix'd Star, having no sensible Parallax,  
 and much elevated above the Horizon, be chosen,  
 whose Place he shews how to determine at P. 164.  
*Prop.* 26. by Observations made when the Star is  
 so high as to have no sensible *Refraction*. Then let  
 the Time be noted when this Star hath any known  
 Altitude (as taken by an Instrument) and Calcu-  
 lation made for the true Altitude, (according to  
 the Star's known Place) the Excess of the observed  
 Altitudes above this is the *Refraction*.

**REFRACTION**, Sir Is. Newton in his *Opticks*,  
 P. 56, 57, 58. on this natural Supposition, that  
*Bodies refract Light by acting upon its Rays in*  
*Lines perpendicular to their Surfaces*, demonstrates,  
*That the Sine of Incidence of every Ray of Light*  
*considered apart, is to its Sine of Refraction in a*  
*given Ratio.* See *Incidence*.

And as he shews that the Sun's Light consists of  
 Rays of different degrees of Refrangibility; so,  
 P. 61. he proves, that the difference of the *Refrac-*  
*tion* of the least refrangible and most refrangible  
 Rays is about the  $27\frac{1}{2}$  Part of the whole *Refraction*  
 of the mean refrangible Rays; and that in  
 some *Refractions*, the *Refraction* of the least to  
 that of the most refrangible Rays, is very nearly  
 as 27 to 28.

Then in *Book II. Part 3*, he demonstrates, that  
 Bodies reflect and refract Light by one and the  
 same Power variously exercised in various Cir-  
 cum-



cumstances, (*See Reflection*); and then he comes to this Proposition, That if Light be swifter in Bodies than in *vacuo*, in the Proportion of the Sines which measure the *Refraction* of those Bodies, then the *Forces of the Bodies to reflect and refract Light, are very nearly proportional to the Densities of the same Bodies*; excepting that unctuous and sulphureous Bodies refract more than others of the same Density. Of this at *P. 73.* he gives a Table, and compares the refracting Power of many Bodies with that of the Air.

And the *Refraction* of the Air is determined by that of the *Atmosphere* observed by *Astronomers*, and he shews that the whole *Refraction* of Light in passing thro' the *Atmosphere*, from the highest and rarest Part of it, down to the lowest and densest, is equal to the *Refraction* it would suffer, in passing at like obliquity out of a *Vacuum* immediately into Air of equal Density with that in the lowest part of the *Atmosphere*.

In particular he shews there, That the *Refractions* of *Pseudo Topaz*, a *Selenitis*, Rock Chrystal, Island Chrystal, vulgar Glass, (*i.e.* Sand melted together) and Glass of Antimony; which are terrestrial, stony, alcalizate Concretes; and of Air, (which probably is the result of such Substances by fermentation) tho' these Substances be very differing from one another in Density, yet have they their refracting Powers almost in the same *Ratio* to one another as their Densities are: Excepting that the *Refraction* of that strange Substance, *Island Chrystal*, is a little greater than the rest. And particularly *Air*, which is 3400 times rarer than the *Pseudo Topaz*, and 4200 times rarer than Glass of Antimony, hath, notwithstanding its rarity, the same refracting Power in respect of its Density, which those two very dense Substances have in respect of theirs; excepting so far as those two differ from one another.

Again, the *Refraction* of *Camphire*, *Oil Olive*, *Linseed Oil*, *Spirits of Turpentine*, *Amber*, which are fat sulphureous Bodies; and a *Diamond*, (which probably is an unctuous Substance coagulated) have their refractive Powers in proportion to one another as their Densities, without any considerable Variation.

But the refractive Power of these unctuous Bodies is two or three times greater in respect of their Densities, than the refractive Powers of the former Substances in respect of theirs.

*Water* hath a refractive Power in a middle Degree between those two sorts of Substances, and probably is of a middle Nature; for out of it grow all vegetable and animal Substances, which consist as well of sulphureous, fat and inflammable Parts, as of earthly, lean, and alkalizate ones.

*Salts* and *Vitriols* have refractive Powers in a middle Degree between those of earthy Substances and Water; and accordingly are composed of those two sorts of Substances; for by Distillation and Rectification of their Spirits,

*Spirits of Wine* have a refractive Power in a middle Degree between those of Water and oily Substances; and accordingly seems to be composed of both, united by Fermentation: The Water, by means of some saline Spirits with which it is impregnated, dissolving the Oil, and volatilizing it by the Action; for Spirit of Wine is inflammable by means of its oily Parts; and being distilled often from Salt of Tartar, grows, by every Distillation, more and more aqueous and flegmatick.

So that it seems rational to attribute the *refra-*

*ctive Power of all Bodies chiefly, if not wholly, to the sulphureous Parts with which they abound.* For its probable, that all Bodies abound more or less with Sulphurs. And as Light congregated by a Burning-glass acts most upon sulphureous Bodies, to turn them into Fire and Flame; so, since all Action is mutual, Sulphurs ought to act most upon Light: And that the Action between Light and Bodies is mutual, appears from hence, that the densest Bodies which refract and reflect Light most strongly, grow hottest in the Summer Sun, by the Action of the refracted or reflected Light.

At the end of his *Latin* Edition of the *Opticks*, under Query 21. he shews, that the cause of *Refraction* (and *Reflexion* both) is the attraction of the Parts of the refracting Body, acting at a little distance upon the Rays of Light as they pass thro' it.

And because the Particles which compose the *Island Chrystal*, (*See Light*) do all act by a consimular Ratio on the Rays of Light, in order to produce that unusual *Refraction* which is observed in that odd Body; therefore 'tis probable, that those Particles in the forming the Parts of that Chrystal, were not only disposed themselves in *certain Order*, so that their Extremities all looking the same way, they did concrete into regular Figures; but also that their *Sides*, that is, such as were homogeneous as to their attracting Forces, by a kind of *Polar Virtue*, or *Polarity*, were all turned the same way.

The same excellent Author shews, *Optick Lat. p. 316.* That having demonstrated in his *Principia*, that if *Refraction* were caused by the attraction of the Rays of Light, the *Sine of the Angle of Incidence* must be to that of the refracted Angle always in a given Ratio; and this being, by repeated Experience, found to be true in Fact: 'tis then plain, that Attraction is the Cause of the Rays of Light.

*REFRACTION Astronomical*, is that which the Atmosphere produceth, whereby a Star appears more elevated above the Horizon than really it is.

*REFRACTION Horizontal*, is that which causeth the Sun or Moon to appear on the Edge of the Horizon, when they are as yet somewhat below it.

*REFRACTION from the Perpendicular*, is when a Ray falling, inclined from a thicker Medium into a thinner, as from Glass into Air, in breaking, departs farther from that *Perpendicular*.

*REFRACTION to the Perpendicular*, is when a Ray falling inclin'd from a thinner or more diaphanous Medium, upon a thicker or less transparent, as from Air upon Water, in breaking, comes nearer the Perpendicular, drawn from the Point of Incidence at right Angles, on the surface of the Water wherein the *Refraction* is made.

*REFRANGIBLE*, is whatever is capable of being refracted.

*REFRANGIBILITY of the Rays of Light*, Sir Isaac Newton defines to be their disposition to be refracted, or turned out of their way, in passing out of one transparent Body or Medium into another; and a greater or less *refrangibility* of Rays is their disposition to be turned more or less out of their way (*in Observat. 24. of his Opticks*) in like Incidences on the same Medium.

He shews also, that there is constant Relation between Colours and *Refrangibility*: The most refrangible Rays being of a *Violet Colour*, the least refrangible *Red*; and those of intermediate Colours,



lours, having proportionably intermediate Degrees of *Refrangibility*.

**REFRIGERATORY**, is that Part of an Alembick or Distilling Vessel which is placed about the Head of the Still, and filled with Water to cool the Head of the Alembick, that the spirituous Vapours may the sooner and the more easily condense into Drops. Cold Water must continually be put into the *Refrigeratory*, as the Vessel grows hot. Most Apothecaries, Distillers, &c. that have occasion for drawing off large Quantities of Spirits, do now-a-days use the *Vesica* or Copper Body with its *Moors-Head* of the same Metal; and without any Refrigerations about the Head of the Still: But there is below, a long Worm or Serpentine in a Tub of Water, where the spirituous Vapours are very easily condensed into a Liquor. And this may as well be called a *Refrigeratory* as the former.

**REFUTATIO** *Feodi*, a Term in Civil Law signifying the Loss of a *Feudal Tenure* by Forfeiture; which is of two Kinds, either by not performing the Service required, or by committing some villanous Act against the Lord or Sovereign.

**REGALIA**, the Royal Rights of a King, reckoned by the *Civilians* to be Six: 1. Power of Judicature. 2. Power of Life and Death. 3. Power of War and Peace. 4. Masterless Goods. 5. Assessments. 6. Minting of Money. Also, the Crown, Scepter with the Cross, Scepter with the Dove, St. *Edward's* Staff, four several Swords, the Globe, the Orb with the Cross, and such other like Things used at the Coronation of our Kings, are called *Regalia*.

Also making Magistrates, or Prerogatives of Favour, such as the Power of making Communities and Colleges, &c.

**REGAL Fishes**, are Whales and Sturgeons, *An. 1. Eliz. c. 5.* to which some add Porpusses. The King by his Prerogative hath every Whale cast ashore in his Dominions, unless granted to Subjects by special Words: The King himself hath the Head and Body, and the Queen the Tail to make Whalebones for her Royal Vestments.



**REGARDANT** [in *Heraldry*] signifies looking behind, and is apply'd to Beasts represented in an Escutcheon, with their Faces turned to their Tails, as in the Figure.

**REGARDERS of the Forest** } were formerly  
**REGARDATORES Forestæ** } a sort of Officers who were every Year, upon Oath, to make a *Regard*, or to make a View of the Forest Limits, and to enquire into all the Damages and Trespases committed, and to present them at the next *Swain Mote* or *Forest Court*. *Manwood* refers their Institution to King *Henry II.* But *Spelman* thinks the Name, at least, was given since; and that then they were the same with those Officers called *Custodes Venationis*. Dr. *Kennet's* *Par. Antiq.*

**REGEL**, or *Rigel*, a Fix'd Star of the first Magnitude in *Orion's* Left-foot; its Longitude is  $72^{\circ} 19'$ , Latitude  $30^{\circ} 10'$ .

**REGIMENT**, is a Body of Troops of Horse, or Companies of Foot, commanded by a Colonel, but the Number is as undetermin'd as that of the Men in a Troop or a Company. There are Regiments of Horse that are not above 300 Men; and

there are some in *Germany* of 2000; and the Regiment of *Picardy* in *France* consists of 6000 Men.

**REGIO** *Assensu*, is a Writ whereby the King gives his Royal Assent to the Election of a Bishop.

**REGION**: *Fernelius*, with some Anatomists, distinguish the Cavities of an animal Body into several Regions or Parts, which they specify into *Publick* and *Private*. The *Publick* are Three: The first includes the *Vena Porta*, and all Parts to which its Branches reach. The second begins at the Roots of the *Vena Cava*, and ends in the small Veins before they become Capillary. The third they make to contain the Muscles, Bones, and Bulk of the Body: But this is not much received. The *Abdomen* is usually distinguished also into three Regions, the *Uppermost*, *Middle* and *Lower*.

*Region* is also taken for our *Hemisphere*, or the Space within the Four Cardinal Points of the Heavens, or of the Air. &c.

— In *Geography*, it signifies a large Extent of Land inhabited by many People of the same Nation, and enclosed within certain Limits or Bounds.

*Region Elementary*, according to the *Aristotelians*, is a Sphere terminated by the Concavity of the Moon's Orb, comprehending the Earth's Atmosphere.

*Region Æthereal* [in *Cosmography*] is the vast Extent of the Universe; wherein are comprised all the Heavens and celestial Bodies.

**REGIONS of the Air**, are distinguished into *Upper*, *Middle*, and *Lower*.

**REGISTERS** [in a *Chymical Furnace*] are Holes purposely left in the Sides of the Furnace with Stopples to them, to let in or keep out the Air, according as the Fire is required to be greater or less.

**REGIUS Professor**, *Anno 12 Car. 2. cap. 17.* King *Henry* the Eighth founded five Lectures in each of our Universities, viz. of *Divinity*, *Hebrew*, *Greek*, *Law*, and *Physick*, the Readers of which, Lectures are, in the University Statutes, called *Regii Professores*.

**REGIUS Morbus**. See *Icterus*.

**REGRATOR**, signifies him that Buys and Sells any Wares or Victuals in the same Market or Fair, or within Five Miles thereof. In the *Civil Law*, such a one is called *Dardanarius*.

**REGULAR Body**, is a Solid whose Surface is composed of *Regular* and *Equal* Figures; and whose Solid Angles are all Equal. Such as the

1. *Tetrahedron*, which is a Pyramid, comprehended under Four Equal and Equilateral Triangles.
2. *Hexahedron*, or Cube, whose Surface is composed of six equal Squares.
3. *Octahedron*, which is bounded by eight Equal and Equilateral Triangles.
4. *Dodecahedron*, which is contained under 12 Equal and Equilateral Pentagons.
5. *Icosihedron*, consisting of 20 Equal and Equilateral Triangles.

That there can be no more *Regular Bodies* besides these may be thus proved.

1. Of *Equilateral Triangles*, there must be three at least to make a Solid Angle; and three of them joined together will make the *Tetrahedron*; for those three Triangles meeting in a Point, do form a Triangular Base similar and equal to the Sides; as appears by the bare Composition of the Figure.

Four



Four such Triangles joined together in a Point, make the Angle of the *Octahedron*.

By joining five such Triangles together, the Angle of the *Icosihedron* is formed.

But six such Triangles joined in a Point, cannot make a Solid Angle; because they make four right ones; (for every Angle of an Equilateral Triangle is  $\frac{1}{3}$  of two; or  $\frac{2}{3}$  of one right Angle; either of which Fractions multiplied by 6, gives four right Angles;) whereas every solid Angle is made up of four such plane Angles as all together must be less than four right ones: So that with Triangles 'tis impossible to form any more *Regular Bodies* than these three.

If you take *Squares* and join three of them together, they will make the Angle of a *Cube*; and there can no other *Regular Body* but a *Cube* be made with *Squares*; for four *Squares* joined together, will not make a solid Angle, but a plane.

If you join the Angles of three *Pentagons* together, you will constitute the Angle of the *Dodecakedron*. But four such Angles cannot make a solid one.

And three *Hexagons* joined together, do make just four right Angles, and therefore they cannot make a solid Angle. And as for three *Heptagons*, or other Figures yet of more Sides, they can much less do it; because their Angles being very obtuse, three of them will exceed four right ones. So that upon the whole, 'tis plain, that of these Five *Regular Bodies*, three are made of *Triangles*, one of *Squares*, and one of *Pentagons*, and there can be no other.

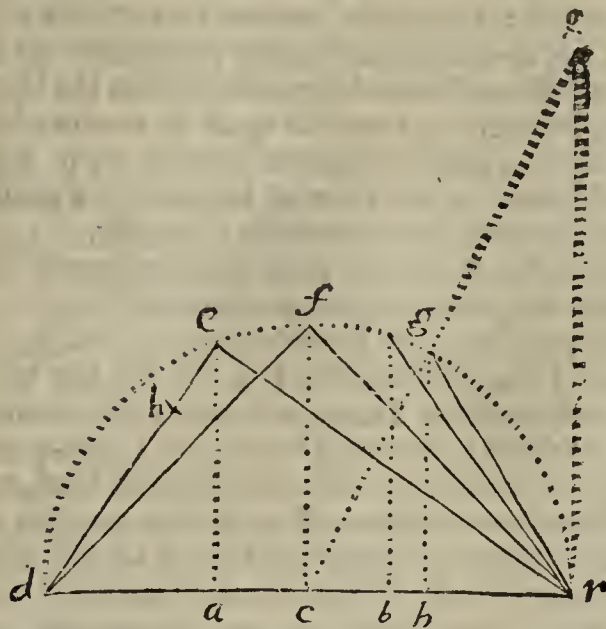
The Proportion of the Sphere, and of the Five Regular Bodies inscribed in the same, from Peter Horigon, *Cursus Math. Vol. I. P. 779.* And Barrow's *Euclid, Lib. 13.*

The Diameter of the Sphere being 2.

|  |           |
|--|-----------|
| The Circumference of the greatest Circle   | 6. 28318  |
| Superficies of the greatest Circles        | 3. 14159  |
| Superficies of the Sphere                  | 12. 56637 |
| Solidity of the Sphere                     | 4. 18859  |
| Side of the <i>Tetrahedron</i>             | 1. 62299  |
| Superficies of a <i>Tetrahedron</i>        | 4. 6188   |
| Solidity of a <i>Tetrahedron</i>           | 0. 15132  |
| Side of a <i>Cube</i> or <i>Hexahedron</i> | 1. 1547   |
| Superficies of the <i>Hexahedron</i>       | 8.        |
| Solidity of the <i>Hexahedron</i>          | 1. 5396   |
| Side of an <i>Octahedron</i>               | 1. 41421  |
| Superficies of the <i>Octahedron</i>       | 6. 9282   |
| Solidity of the <i>Octahedron</i>          | 1. 33333  |
| Side of the <i>Dodecakedron</i>            | 0. 71364  |
| Superficies of the <i>Dodecakedron</i>     | 10. 51462 |
| Solidity of the <i>Dodecakedron</i>        | 2. 78516  |
| Side of the <i>Icosihedron</i>             | 1. 05146  |
| Superficies of the <i>Icosihedron</i>      | 9. 57454  |
| Solidity of the <i>Icosihedron</i>         | 2. 53615  |

If one of these Five *Regular Bodies* were requir'd to be cut out of the Sphere of any other Diameter, 'twill be as the Diameter of the Sphere 2 is to the Side of any one Solid inscribed in the same, (suppose the *Cube* 1. 1547.) so is the Diameter of any other Sphere (suppose 8.) to 9. 2376, the Side of the *Cube* inscribed in this latter Sphere.

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Let  $dr$  be the Diameter of any Sphere, and  $da$   $\frac{1}{2}$  of it.  $= ab = br$ . Erect the Perpendiculars  $ae, ef,$  and  $bg$ , and draw  $de, df, er, fr,$  and  $gr$ .

Then will

1.  $re$  be as the Side of the *Tetrahedron*.
2.  $df$  is the Side of the *Hexahedron*.
3.  $de$  is the Side of the *Octahedron*.
4. Cut  $de$  in extrem and mean Proportion in  $b$ , and  $db$  will be the Side of the *Dodecakedron*.
5. Set the Diameter  $dr$  up perpendicularly at  $r$ , and from the Centre  $c$ , to its Top, draw the Line  $cg$  cutting the Circle in  $g$ . Let fall the Perpendicular  $gb$ . So is  $br$  the Side of the *Icosihedron*.

REGULAR Figures, [in Geometry] are such whose Sides, and consequently their Angles, are all equal to one another.

Whence all *Regular* multilateral Planes are call'd *Regular Polygons*.

The Area of such Figures is speedily found by multiplying a Perpendicular let fall from the Centre of the Inscribed Circle to any Side by half that Side, and then that Product by the Number of the Sides of the Polygon.

REGULAR Fortification. See *Fortification*.

REGULAR Curves, are such Curves as the Perimeters of the Conick Sections, which are always curved after the same Regular Geometrical manner.

But Irregular Curves, are such as have a Point of Inflexion; and which being continued, do turn themselves a contrary way, as the *Conchoid*, and the Solid *Parabola* which hath a Square for its *Parameter*.

REGULATOR, a small Spring belonging to the *Balance* in the new Pocket-Watches.

REGULUS. See *Basilicus*.

REGULUS, or *Regule*. When any Metal or Mineral is separated in a Crucible, by Purification, from its more gross and terrene Parts, the finer and metalline Parts will sink to the Bottom of the Crucible. And this the Chymists call *Rex* or *Regulus*, the Royal or Noble Part of the Mixture.

REGULUS of *Antimony* is thus made: Mix together 16 Ounces of *Antimony*, 12 of crude *Tartar*, and 6 of *Salt-petre*, all well powdered; then heat a large Crucible red-hot, and throw into it a Spoonful of the Mixture, presently covering the Crucible with a Tile; repeat this Spoonful by Spoonful till all the Matter is thrown in. Then make a great Fire about the Crucible, and when the Matter hath been a while melted, pour



it into an Iron Mortar greased a little with Suet, and warm'd; knock the Mortar on the Side with the Pestle, to make the *Regulus* precipitate to the Bottom. When 'tis cold separate it from the Dross, then Powder it, and melt it again in another Crucible, with a little *Salt-petre* thrown on it when 'tis in Fusion. Cast it out as before into a greased Mortar, or mould it into Pills, Cups, &c.

For of this *Regulus* is made the *Antimonial Cup*. And the *Regulus*, if you powder four Ounces of it and calcine it in an Earthen Pan, unglaz'd, over a small Fire, stirring the Powder all the while with a Spatula, a Fume will arise, for about an Hour and half, or two Hours, the Powder will turn grey, and, at the end of that small time, will weigh near two Drams and an half more than the Powder did at first, tho' it fumed all the time; which may satisfy us, that some Bodies have their Pores so adapted, that they can detain the very Particles of Fire themselves, and Incorporate with them. An augmentation of Weight happens in making the Calx of Lead, and some others, but not in such a degree, nor so soon as this.

If an Ounce of the Dross of the *Regule of Antimony*, be boiled in a Pint of Water, and then set to stand and cool without stirring it, it will coagulate into a Substance very like to Blood, but not so red.

The Chymists make much ado about a *Regulus of Antimony* made with Steel, because of a kind of Star that appears at the bottom of it: But it hath no other Vertues than this described above. You may see the way of making it in *Lemery*, p. 265. *last Edit.* and in many other Chymical Authors.

If *Antimony* be calcined in an Earthen Pot, unglazed, and continually stirring till no more Fumes arise; and afterwards the Matter be put into a Crucible, and in a very violent Fire melted and kept an Hour in Fusion, it will be turned into a reddish opake Glass, which they call *Glass of Antimony*, and is a most violent Emetick.

REHABERE *facias seisinam, quando Vicecomes liberavit seisinam de majore parte quam deberet*, is a Writ Judicial, mention'd *Reg. Judic. fol. 13.51.* and in *fol. 54.* there is another Writ mentioned of this Name and Nature.

REHABILITATION *Anno 25 H. 8. cap. 21.* was one of those Exactions mentioned in that Statute to be claimed heretofore by the Pope in *England*; and seems to signify a *Bull* or *Breve*, for re-enabling a spiritual Person to exercise his Function, that was formerly disabled.

RE-INFORCED *Ring of a Cannon*, is that which is next after the *Trunnions*, between them and the *Vent*; and the *Re-inforced* part of a Gun, is from the Base Ring to the *Re-inforced* Ring. This part is made thicker in Metal than any other part of the Piece.

REJOYNDER, [in *Law*] signifies an Answer or Exception to a Replication; for first the Defendant puts in an Answer to the Plaintiff's Bill, which is sometimes called, *An Exception*; the Plaintiff's Answer to that is called, *a Rejoynder*, especially in Chancery. 'Tis by the Civilians called *Duplicatio*.

REJOYNTING [in *Architecture*] is the filling up the Joynts of the Stones in old Buildings, &c. when they are worn hollow by course of Time or Water.

RELAIS, a *French* Term in *Fortification*, the same with *Berme*.

RELATION *Inharmonical*, a Term in Musical Composition, signifying a harsh Reflection of Flat against Sharp, in a cross Form, *viz.* When some harsh and displeasing Discord is produced, in comparing the present Note of another Part.

RELATION [in *Geometry*, &c.] is the habitude or respect of two Quantities to one another, with respect to their Magnitude, more commonly called *Ratio*.

RELATION [in the *Law* sense] is the same as *Fictio Juris*, to make a Nullity of a thing from the beginning (for a certain Intent) which had Essence, (*Vide Co. Lib. 3. fol. 28. Butler and Baker's Case*) but more plainly thus: *Relation* is where, in consideration of Law two *Times*, or other things are considered so, as if they were all one; and by this the thing subsequent is said to take its Effect by *Relation*, at the *Time preceding*. As if *A* deliver a Writing to *B*, to be delivered to *C*, as the Deed of *A*, when *C* has paid a Sum of Money. Here when the Money is paid, and the Writing delivered, this shall be taken as the Deed of *A*, at the Time when it was first delivered. And so Bills of Parliament, to which the King assents on the *last* Day of Parliament, shall *Relate* and be of Force from the *first* Day of the Session.

RELATIVE [in *Grammar*] is a Word or Term which, in the Construction, answers to some Word that goes before, that is called the Antecedent.

RELATIVE *Gravity*, the same with *Specifick*; which see.

RELATIVE *Propositions*, are those that include some Comparison, and some Relation, thus: *Where the Treasure is, there is the Heart: As much as thou hast, so much art thou worth.*

RELAXANTIA. See *Chalastica*.

RELAXATION, is a Dilatation of Parts or Vessels.

RELAXATION [in *Surgery*] is a preternatural Extention or straining of a Nerve, Tendon, Muscle, or the like, either thro' Violence or Weakness.

RELEASE [in *Law*] is an Instrument whereby Estates, Rights, Titles, Entries, Actions, and other Things, be sometimes extinguished, sometimes transferred, sometimes abridged, and sometimes enlarged; and is either *in Fact* or *in Law*.

*A Release in Fact*, is that which the very Words expressly declare.

*A Release in Law*, is that which doth *Acquit* by way of Consequence or Intendment of Law.

RELEGATION [in *Law*] signifies a Banishment for a certain time.

RELEIFE, or *Relievo*, is the protuberant jetting or standing out of any Figures or Images above the Plain on which they are formed. And whatever Figures or Representations are thus cut, stamped, or otherwise wrought, so that not the entire Body, but only part of it is raised above the Plain, is said to be done in *Releife*; and when the Work is low, flat, and but a little raised, 'tis called *Basse Releife*, or *Low Releife*. When a Coin or a Medal hath its Figure low and thin, and hardly distinguishable from the Plain, we say its *Releife* is low and weak; but when 'tis much raised, we say 'tis *Bold*, and its *Releife* is Strong.

RELEVISH [in *Law*] signifies to let one to Mainprise upon Surety.

RELICTA *Verificazione*, is when a Defendant hath Pleaded, and the Issue is entred of Record, and after that the Defendant *Relicta Verificazione* (*que est son Plea*) acknowledges the Action, and thereupon Judgment is entred for the Plaintiff.

RELIEF,



**RELIEF**, *Relevamen*, (in Doomsday *Relevatio Relevium*) was a certain Sum of Money, which the Tenant holding by Knight's Service, Grand Sergeantry, or other Tenure, for which Homage or Regal Service is due; or by Soccage, for which no Homage is duely paid to his Lord at his Entrance, *Mag. Cart. c. 2.* and *38 Ed. 1. Stat. 1. Skene de Verbor.* saith, *Relief* was given by the Tenant or Vassal that was of perfect Age, after the expiring of his Wardship, to the Superior Lord, of whom he held his Lands in Knight Service: that is, by *Ward* and *Relief*; for by payment thereof he *Relieves*, and as it were *releuat*, raiseth up again his Lands after they were sunk into his Superiors Hand, by reason of Wardship, &c. See also *12 Car. 2. c. 24.*

**RELIEF**, *Relevium*, was a Fine formerly paid to the King by every one that came to the Inheritance of Land held in *Capite*, or *Military Service*, to *Relieve*, or, as it were, to redeem their Estate, and to hold Possession of it. At first it consisted in Horses and Arms, till by the *Affise* of Arms in *27 Henry II.* every Man's Armour was preserved for his Heir, and the *Relief* payable in Money, of which the fixt Rates were determin'd by *Magna Charta*.

**RELIEFS** were payable also not only to the King as Supream Lord, but to all Barons and Knights by those Tenants who held under them by Military Service. *Relevare* was the Word for paying such *Relief*, and for obtaining by that means Possession of such Estate.

Some Customary and Servile Tenants paid a *Relief* for renewing of a *Tenure*, on the Death of the last Possessor. *Kennet's Paroch. Antiq.*

**REMAINDER** [in *Law*] is an Estate limited in Lands, Tenements, or Rents, to be enjoyed after the expiration of another particular Estate. As a Man may let to one for Term of his Life, and the *Remainder* to another for the Term of his Life; and this *Remainder* may be either for a certain Term, or in Fee-simple, or Fee-taile; the difference between a *Remainder* and *Reversion*, is this, That by a *Reversion*, after the appointed Term, the Estate returns to the Donor, or his Heirs, as the proper Fountain; whereas by *Remainder*, it goes to some third Person, or a Stranger.

**REMEMBRANCE**, is when the Idea of something formerly known recurs again into the Mind, without the Operation of the like Object on the external Sensory.

**REMEMBRANCERS** of the *Exchequer*, are three Officers or Clerks there, viz. *The King's Remembrancer*, *the Lord Treasurer's Remembrancer*, and *the Remembrancer of the First Fruits*.

*The King's Remembrancer* enters into his Office all Recognizances, taken before the Barons, for any of the King's Debts, for Appearance, or for observing Orders; and maketh out Process against the Collectors of Customs, Subsidies, and Fifteenths, for their Accounts: All Informations upon Penal Statutes are entred in this Office, and there all Matters upon *English Bills* in the Exchequer-Chamber remain: He makes the Bills of Composition upon Penal Laws, takes the Stalment of Debts, has delivered into his Office all manner of Indentures, Fines, and other Evidences whatsoever, that concern the assuring of any Lands to the Crown: He every Year in *crastino animarum* reads in open Court, the Statute for Election of Sheriffs, and gives them their Oath: and he reads in open Court the Oath of all the Officers of the same,

when they are admitted; besides many other Things.

*The Lord Treasurer's Remembrancer*, upon whose Charge it lies to put the Lord Treasurer, and the rest of the Judges of that Court, in *Remembrance* of such Things as are to be call'd on, and dealt in for the King's Behoof. He makes Process against all Sheriffs, Escheators, Receivers, and Bailiffs, for their Account: He makes Process of *Fieri facias* & *Extent*, for any Debts due to the King, either in the Pipe or with the Auditors; makes Process for all such Revenues as are due to the King, by reason of its Tenures: He makes Record, whereby it appears whether Sheriffs, and other Accomptants, pay their *Profers* due at *Easter* and *Michaelmas*: He makes another Record, whether Sheriffs, and other Accomptants, keep their Days of Prefixion. All Estreats of Fines, Issues, and Amerciaments, set in any Courts at *Westminster*, or at the Assizes, or Sessions, are certified into this Office, and are by him delivered to the Clerk of the Estreats, to write Process upon them, &c.

*The Remembrancer of the First Fruits*, takes all Compositions and Bonds for *First Fruits* and *Tenths*, and makes Process against such as do not pay the same.

**REMINISCENCE**, is the Power which the Humane Mind hath of recollecting it self, or calling again to its Remembrance such Ideas or Notions which it had really forgot: In which it differs from *Memory*, which is a treasuring up of Things in the Mind, and keeping them there without forgetting them.

**REMISSION**, is a Word used by Physical Writers, to signify the Abatement of the Power or Efficacy of any Quality; as when it is Increased, they say 'tis Intended; and all Qualities are thus capable of *Intension* or *Remission*.

See in the Word *Quality*, a Demonstration that the *Intension* of all Qualities decreases, as the Squares of the Distance from the Centre of Action reciprocally.

**REMITTER**, in a Legal Sense, is to restore one that hath two Titles to Lands or Tenements, and is seized of them by a latter Title which is discovered to be defective, to the former and more ancient Title, that so he may continue in Quiet Possession.

**REMORA** [in *Surgery*] an Instrument for setting broken Bones.



**REMPLI** [in *Heraldry*] is something filled up; a Term us'd chiefly to signify that the Chief is quite filled up with a square piece of another Colour, leaving only a Border for the proper Colour of the Chief about the said Piece.

**RENAL Artery**, is said, by some, to come out of the *Aorta*, and to enter into the Kidneys, bringing to it the Serosity of the arterial Blood.

**RENALES Glandulae** [in *Anatomy*] are the Glands that are situated near the Reins or Kidneys.

**RENALIS.** See *Adiposa Vena*.



**RENCONTRE** [in *Heraldry*] is apply'd to Animals when they shew the Head in Front, with both Eyes, &c. or the Face stands right forwards, as if they came to meet the Person before them.

**REN-**



RENDER [in *Law*] is a Word used in levying of a Fine, which is either single, whereby nothing is granted or rendred back again by the Cognizee to the Cognizor, or double, which containeth a Grant or render back again of some Rent, Common, or other Thing out of the Land itself to the Cognizor, &c.

Also, there be some Things in a Manour that lie in *Prender*; that is, which may be taken by the Lord or his Officer, when they change, without any Offer made by the Tenant, as Elcheats, and the like; and some that lie in *Render*; that is, must be delivered or answered by the Tenants, as Rents, Reliefs, Heriots, and other Services. Also some Service consists in *Seizance*, some in *Render*.

RENDS [in a *Ship*] are the same as the Seams between her Planks.

RENES, the *Reins* or *Kidneys*; there are always two of them, and placed in the *Abdomen*, between the two Membranes of the *Peritonæum*, and adjoining to the Sides of the *Aorta* and *Vena Cava*; the Right Kidney lies lower in Men, and is something less than the Left: They are covered with a double Membrane; of which the outwardmost is common, proceeding from the *Peritonæum*; and is called the *Membrana Adiposa*, from its being covered with Fat, in fat and corpulent People; into this the *Arteria Adiposa* enters from the *Aorta*; and the *Vena Adiposa* goes out from it, which the right Kidney usually sends into the *Emulgent Vein*, rarely into the *Cava*, but the left Kidney generally into the *Cava*. By means of this *Membrane*, both the Kidneys are joined to the *Loins* and *Diaphragma*: The right one to the *Cæcum Intestinum*, and sometimes to the Liver, and the left is connected by it to the Spleen and Colon.

Its Interior Membrane or Tunick, and which is proper to it, is taken from the external Root of those Vessels which enter the Kidneys, (and which do enter it but with a single Coat:) and this hath some small Nerves from a Branch of the sixth Pair, and from the *Stomachick Branch*, which give the Kidneys but a dull small Sense, but afterwards branched out into the *Ureters*, render them extremely sensible; and those Nerves (by consent of Parts) cause that Vomiting which usually accompanies Nephritick Pains. The Kidneys have two eminent Blood Vessels, the *Emulgent Vein* and *Artery*; of which the latter distributes the Blood from the *Aorta* into the Body of the Kidneys, and the former brings it back again.

RENES *Succenturiati*, are a Pair of glandulous Bodies placed above the Reins or Kidneys: Their Use (by some) is supposed to be, to receive the Lympha into their Cavities, thereby to attenuate and render more fluid and capable of Circulation, the Blood returning from the Kidneys, where it hath parted with its *Serum*. But we are yet, saith Dr. *Gibson*, in the dark as to their true Use: They are called also *Glandulæ Renales*, and by *Bartholin* *Capsulæ Atrabiliaræ*: By Dr. *Wharton*, *Glandulæ ad Plexum Nerveum sitæ*. They are larger in Children than in Men; being in the former near as big as the Kidneys, but they do not increase proportionably as other Parts do.

RENEWING of *Leases* and *Lives*, &c. (See also *Reversions*. Tho' there be variety of Tables extant for computing Interest and Annuities, yet till the little Book of Tables for *Renewing* and *Purchasing* *College* and *Church* *Leases*, was published at *Cambridge* (and recommended by the

Famous Sir *Isaac Newton*) there was a Defect in this Affair. But there the Tables are not only easy and commodious, and their Construction clear; but the *Ground* and *Reasons* of *Renewing*, are given, from the Construction and Use of a little Table of *Reversions*; which you will find inserted here, with its Use and Application under the Word *Reversion*.

I have therefore given you the following plain and easy Tables of *Renewing*, from the said Book; by the Use of which the *Renewing* of *Leases* or *Lives*, will become a clear, facile and intelligible Thing.

And altho' these Tables are only for Leases of 21, 20, 40, and 10 Years; yet by the Table of *Reversions* abovementioned, other Tables of *Renewing* of *Leases* for any Number of Years under 41, may be made; as by this Example will appear.

Suppose in a Lease of 31 Years I would renew 7 Years lapsed, allowing 6l. per Cent. Profit. To do this, I take the Sum of the *Reversions* for 7 Years from 31 upwards. (from the Table of *Reversions*) accounting 31 as 1; which Sum is 1l. 7s. 7d. 0q. or according to the way of accounting in the following Tables, 1 Year, 2 Quarters, 1 Month, and 5 Decimal Parts, Purchase; and that is the Fine to be paid for renewing the 7 Years lapsed, and which was sought.

And this being understood, it will not be difficult to do the like for any other number of Years, either in this or any other Lease, and according to any other Rate of Interest.

As to the Nature of the following Tables, they differ a little from Mr. *Æcroids*, in the Rate of Interest for which they are calculated.

Mr. *Æcroids* are made at 11l. 3s. 6d.  $\frac{6}{17}$  per Cent. But this Table for renewing a Lease of 21 Years, is calculated at 11l. 11s. 8d.  $\frac{1}{4} \frac{1}{16}$ , and at, 5, 6, 8 and 10 per Cent. So the Fine for renewing 7 Years lapsed in a Lease of 21 Years, by *Æcroids* Tables is 1l. 1s. 3d. (i. e.) 1 Year and 3 Weeks purchase: But by our Tables it is but one Years Value, at 11l. 11s. 8d.  $\frac{1}{4} \frac{1}{16}$  per Cent. The Reason of which is, because the Rate of Interest is greater: But when the Rate of Interest is lesser, then the Fine is greater.

Thus at 10l. per Cent. the Fine for renewing 7 Years lapsed, is 1 Year, 1 Quarter, and 1 Week's Value: But at 8l. per Cent. the Fine for renewing 7 Years lapsed, is above 1 Year and 3 Quarters Value; and at 6l. per Cent. the Fine is 2 Years and almost  $\frac{1}{2}$  Value.

So in the Table for renewing a Lease of 20 Years at 22l. 6s. per Cent. the Fine for renewing 7 Years lapsed, is but one Year's Value in these Tables; whereas in his, it is 1l. 3s. 8d. that is, one Year and above two Months Value. But at 5, 6, 8, and 10l. per Cent. the Fine is greater, because the Rate of Interest is less, as was said above.

And that this is right, will appear, if you consider that the Tables for *Renewing* of *Leases*, consist of the Sums of the Tables of *Reversion*, or decrease of Money.

For 'tis apparent, that the greater the Rate of Interest is, the greater is the Decrease of Money in the Reversion: And consequently, the lesser are the Sums of those Reversions, which are the Fines for *Renewing*. An Example will make this very plain.

If you look into the Table of *Reversions*, you will find; That 1l. or 20s. in 40 Years decreases



to two Pence Half-penny at 12*l. per Cent.* Compound Interest; and at 10*l. per Cent.* it decreases to 5 Pence Farthing in 40 Years: Now the Sum of these Reversions for 7 Years, accounting 40 as 1; 39 as 2, &c. is but 2*s.* 1*d.* 2*q.* But at 10 *per Cent.* the Sum for seven Years is 4*s.* 2*d.* 3*q.* which Sums are the *Fines* for renewing 7 Years lapsed in a Lease of 40 Years, at the Rates of 12, and 10 *per Cent.*

From whence 'tis clear and plain, that the *lesser* the Rate of Interest is, the *greater* must be the *Fine* for renewing: And the *greater* that Rate is, the *lesser* must be the *Fine*: And consequently the Difference between these Tables and *Æcroid's* arises only from the different Rate of Interest for which they were calculated.

The following Tables for renewing and purchasing of Leases, do shew the Value in *Years, Quarters, Months,* and *Decimal Parts* of a Month, accounting 3 Months to a Quarter, and that a Month is divided into Ten Parts. And tho' this way of Division be not quite so exact, as if it were express'd in Decimals of *Pounds, Shillings, Pence,* &c. yet 'tis more familiar and commodious, and the Difference is very inconsiderable, for it will never be above a Decimal of a Month over or under the true Value, which in these Considerations is not to be regarded. And therefore when a Fine is required of any Person, either for renewing or purchasing of a Lease, the Tables will shew exactly enough what *Rate* of Interest is allowed; And so if any one would *give* or *take* a Fine according to any Rate of Interest proposed, they may do it near enough by the Tables.

At 1*l. per An.* Rent, the Divisions by these Tables will be 5*s. per Quarter,* 1*s.* 8*d. per Month,* and a Decimal of a Month 2*d.* And because there are 4 Weeks in a Month it will be 5*d. per Week;* five Decimals of a Month therefore make 10*d.* which are equal to 2 Weeks, and 3 Decimals of a Month are but 1 Penny above a Week; so that 'tis easy to turn the Decimal Parts of a Month into Weeks.

And these kind of Numbers will be easily added or subtracted, as in these two Examples.

|                       | Y. | Q. | M. | D.p. |
|-----------------------|----|----|----|------|
| Suppose I were to add | 3  | 2  | 1  | 6    |
| these two Fines,      | 2  | 3  | 1  | 7    |
| Sum                   | 6  | 2  | 0  | 3    |

#### A D D I T I O N.

I say 7 and 6 makes 13 Decimals, 10 of which making a Month, I write 3 and carry 1; 11 carried and 2 Months makes 3 Months; wherefore I write a 0 and carry 1 Quarter, &c.

And this being understood, Subtraction will also be easy, as in this Instance.

|          | Y. | Q. | M. | D.p. |
|----------|----|----|----|------|
| If from  | 3  | 2  | 1  | 6    |
| You take | 2  | 3  | 1  | 7    |
| Remains  | 0  | 2  | 2  | 9    |

The first Table which offers it self for Renewing of Leases, is for the Term of 21 Years, it shews the Values in *Years, Quarters, Months,* and *Decimal parts* of a Month, as all the rest do: The first part of this Table is calculated at 11*l.* 11*s.* 8*d.*  $\frac{1}{4}$ .  $\frac{3}{4}$ . *per Cent. per An.* Compound Interest, so that the Fine for Renewing 7 Years Lapsed, or the present Worth of 7 Years in Reversion, not to begin till 14 are expired, is exactly one Years Value; which Fine, and consequently Rate of Interest, Bishops, Deans and Chapters, Heads and Fellows of most Colleges in both Universities, do observe in Letting and Renewing of their Leases; but at other Rates of Interest, the Fine for Renewing 7 Years lapsed, the Table shews as followeth, viz.

#### The Fine for Renewing 7 Years Lapsed

|                     | Y. | Q. | M. | D.p. | l. | s. | d. |
|---------------------|----|----|----|------|----|----|----|
| at 5 <i>p.c.</i> is | 1  | 3  | 2  | 0    | 29 | 3  | 4  |
| 6 <i>p.c.</i> is    | 2  | 1  | 2  | 6    | 24 | 13 | 4  |
| 8 <i>p.c.</i> is    | 1  | 3  | 0  | 3    | 17 | 15 | 0  |
| 10 <i>p.c.</i> is   | 1  | 1  | 0  | 3    | 12 | 15 | 0  |

The Years *in esse* may be valued as a Lease of so many Years, as in this Lease of 21 Years, if 7 Years are run out, then there are 14 *in esse*, whose Value are as a Lease of 14 Years, and may be found by the Table for Purchasing; or if you subtract the Value of the Years in Reversion from the Value of the whole Lease, the Remainder is the Value of the Years *in esse*.

To find the Value of some of the Years in Reversion, as suppose 3 of the 7, I do thus, because 3 wants 4 of 7, I take the Value of 4 Years in Reversion, from the Value of 7 in Reversion, the Remainder is the Value of 3 Years required.

#### Example.

|   |    |    |    |      |
|---|----|----|----|------|
| The Value of 7 Years in Reversion, at 11 <i>l.</i> 11 <i>s.</i> 8 <i>d.</i> <i>per Cent.</i> is | Y. | Q. | M. | D.p. |
|   | 1  | 0  | 0  | 0    |
| The Value of 4 Years in Reversion at the same Rate is   | 0  | 1  | 2  | 7    |
| Which subtract  |    |    |    |      |

|   |   |   |   |
|---|---|---|---|
| 0 | 2 | 0 | 3 |
|---|---|---|---|

Which Remainder being given for a Fine, will make up the Lease to 17 Years, that is, 3 added to 14.



A Table for the Renewing of any Number of Years lapsed in a Lease for 21 Years.

| 11 l. 11 s. 8 d. $\frac{1}{4}$ p. c. |        |           |                | 5 per Cent.    |           |         |                | 6 per Cent.    |           |         |                | 8 per Cent.    |           |         |                | 10 per Cent.  |           |         |                |
|--------------------------------------|--------|-----------|----------------|----------------|-----------|---------|----------------|----------------|-----------|---------|----------------|----------------|-----------|---------|----------------|---------------|-----------|---------|----------------|
| Years Lapsed.                        | Years. | Quarters. | Decimal Parts. | Years.         | Quarters. | Months. | Decimal Parts. | Years.         | Quarters. | Months. | Decimal Parts. | Years.         | Quarters. | Months. | Decimal Parts. | Years.        | Quarters. | Months. | Decimal Parts. |
| 1                                    | 0      | 0         | 4              | 0              | 1         | 1       | 3              | 0              | 1         | 0       | 5              | 0              | 0         | 2       | 4              | 0             | 0         | 1       | 6              |
| 2                                    | 0      | 0         | 5              | 0              | 2         | 2       | 8              | 0              | 2         | 1       | 2              | 0              | 1         | 2       | 0              | 0             | 1         | 0       | 4              |
| 3                                    | 0      | 1         | 0              | 1              | 0         | 1       | 5              | 0              | 3         | 2       | 2              | 0              | 2         | 1       | 7              | 0             | 1         | 2       | 3              |
| 4                                    | 0      | 1         | 7              | 1              | 2         | 0       | 5              | 1              | 1         | 0       | 4              | 0              | 3         | 1       | 7              | 0             | 2         | 1       | 5              |
| 5                                    | 0      | 2         | 6              | 1              | 3         | 2       | 8              | 1              | 2         | 1       | 8              | 1              | 0         | 2       | 0              | 0             | 3         | 0       | 8              |
| 6                                    | 0      | 3         | 0              | 2              | 1         | 2       | 3              | 2              | 0         | 0       | 6              | 1              | 1         | 2       | 5              | 1             | 0         | 0       | 4              |
| 7                                    | 1      | 0         | 0              | 2              | 3         | 2       | 0              | 2              | 1         | 2       | 6              | 1              | 3         | 0       | 3              | 1             | 1         | 0       | 3              |
| 8                                    | 1      | 0         | 6              | 3              | 1         | 2       | 1              | 2              | 3         | 1       | 9              | 2              | 0         | 1       | 4              | 1             | 2         | 0       | 5              |
| 9                                    | 1      | 1         | 5              | 3              | 3         | 2       | 4              | 3              | 1         | 1       | 5              | 2              | 1         | 2       | 8              | 1             | 3         | 1       | 0              |
| 10                                   | 1      | 2         | 7              | 4              | 2         | 0       | 1              | 3              | 3         | 1       | 5              | 2              | 3         | 1       | 5              | 2             | 0         | 1       | 8              |
| 11                                   | 2      | 0         | 3              | 5              | 0         | 1       | 1              | 4              | 1         | 1       | 8              | 3              | 1         | 0       | 7              | 2             | 2         | 0       | 0              |
| 12                                   | 2      | 1         | 3              | 5              | 2         | 2       | 5              | 4              | 3         | 2       | 5              | 3              | 3         | 0       | 2              | 2             | 3         | 1       | 6              |
| 13                                   | 2      | 2         | 8              | 6              | 1         | 1       | 2              | 5              | 2         | 0       | 6              | 4              | 1         | 0       | 2              | 3             | 1         | 0       | 7              |
| 14                                   | 3      | 0         | 8              | 7              | 0         | 0       | 3              | 6              | 0         | 2       | 1              | 4              | 3         | 0       | 7              | 3             | 3         | 0       | 3              |
| 15                                   | 3      | 2         | 3              | 7              | 2         | 2       | 8              | 6              | 3         | 1       | 1              | 5              | 1         | 1       | 7              | 4             | 1         | 0       | 4              |
| 16                                   | 4      | 0         | 5              | 8              | 1         | 2       | 8              | 7              | 2         | 0       | 6              | 6              | 0         | 0       | 2              | 4             | 3         | 1       | 2              |
| 17                                   | 4      | 2         | 5              | 9              | 1         | 0       | 2              | 8              | 1         | 0       | 5              | 6              | 2         | 2       | 4              | 5             | 1         | 2       | 7              |
| 18                                   | 5      | 1         | 3              | 10             | 0         | 1       | 1              | 9              | 0         | 1       | 0              | 7              | 1         | 2       | 2              | 6             | 0         | 1       | 9              |
| 19                                   | 6      | 0         | 9              | 10             | 3         | 2       | 4              | 9              | 3         | 2       | 1              | 8              | 0         | 2       | 8              | 6             | 3         | 1       | 9              |
| 20                                   | 6      | 3         | 5              | 11             | 3         | 1       | 3              | 10             | 3         | 0       | 8              | 9              | 0         | 1       | 1              | 7             | 2         | 2       | 8              |
| Total Value                          |        |           |                | Total Value.   |           |         |                | Total Value    |           |         |                | Total Value    |           |         |                | Total Value   |           |         |                |
| 7   3   0   3                        |        |           |                | 12   3   0   8 |           |         |                | 11   3   0   1 |           |         |                | 10   0   0   2 |           |         |                | 8   2   1   7 |           |         |                |

The next Table is for the Term of 20 Years, the first part thereof is calculated according to the Rate of about 12 l. 6 s. per Cent. per Ann. so that 1 Years value is the Worth of 7 Years lapsed, or in Reversion; which Fine, and consequently Rate of Interest, by some, is observed in a Lease for 20 Years, but at other Rates of Interest: The Fine for Renewing 7 Years lapsed in this Lease of 20 Years you will find by the Table as followeth, viz.

The Fine for Renewing 7 Years lapsed.

|               | Y. Q. M. D. pts. |                 | l. s. d. |
|---------------|------------------|-----------------|----------|
| at 5 p. c. is | 3 0 0 8          | Which by the    | 30 13 4  |
| 6 p. c. is    | 2 2 1 4          | Table of Red.   | 26 3 4   |
| 8 p. c. is    | 1 3 1 9          | at 10 l. yearly | 19 1 8   |
| 10 p. c. is   | 1 1 1 8          | Rent is         | 14 0 0   |

The Years *in esse* may be valued as a Lease of so many Years, or their Value may be found, by subtracting the Value of the Years lapsed, from the Value of the whole Lease, as was directed before in the Lease of 21 Years.

The Value of some of the Years in Reversion may also be found in this Lease, as is directed before in the former Lease; however, to make all plain, I shall give one Example: As suppose, I am to find the Value of 4 of the 7 Years in Reversion in this Lease; then according to the Rule given in the Lease of 21 Years, I do thus; because 4 wants 3 of 7, I take the Value of 3 Years in Reversion, from the Value of 7 in Reversion, the Remainder is the Value of the 4 Years required.

Example.

|   |                |
|---|----------------|
| The Value of 7 Years in Reversion at 6 l. per Cent. | Y. Q. M. D. p. |
| The Value of 3 Years at the same Rate is            | 2 2 1 4        |
| Which subtract                                      | 0 3 2 9        |
| Remains   | 1 2 1 5        |

This Remainder being given for a Fine will make up this Lease to 17 Years, that is, 4 added to 13.



A Table for the Renewing of any Number of Years lapsed in a Lease for 20 Years.

| 12 l. 6 s. p.c. |        |           |         |                | 5 per Cent.    |           |         |                |        | 6 per Cent.    |         |                |        |           | 8 per Cent.   |                |        |           |         | 10 per Cent.   |  |  |  |  |
|-----------------|--------|-----------|---------|----------------|----------------|-----------|---------|----------------|--------|----------------|---------|----------------|--------|-----------|---------------|----------------|--------|-----------|---------|----------------|--|--|--|--|
| Years Lapsed.   | Years. | Quarters. | Months. | Decimal Parts. | Years.         | Quarters. | Months. | Decimal Parts. | Years. | Quarters.      | Months. | Decimal Parts. | Years. | Quarters. | Months.       | Decimal Parts. | Years. | Quarters. | Months. | Decimal Parts. |  |  |  |  |
| 1               | 0      | 0         | 1       | 2              | 0              | 1         | 1       | 5              | 0      | 0              | 1       | 7              | 0      | 0         | 2             | 6              | 0      | 0         | 1       | 8              |  |  |  |  |
| 2               | 0      | 0         | 2       | 5              | 0              | 3         | 0       | 3              | 0      | 2              | 1       | 7              | 0      | 0         | 1             | 2              | 0      | 1         | 0       | 7              |  |  |  |  |
| 3               | 0      | 1         | 1       | 0              | 1              | 0         | 2       | 2              | 0      | 0              | 3       | 2              | 0      | 0         | 2             | 2              | 0      | 1         | 2       | 0              |  |  |  |  |
| 4               | 0      | 1         | 2       | 6              | 1              | 2         | 1       | 5              | 1      | 1              | 1       | 4              | 0      | 0         | 3             | 2              | 0      | 2         | 2       | 2              |  |  |  |  |
| 5               | 0      | 2         | 1       | 5              | 2              | 0         | 1       | 0              | 1      | 3              | 0       | 1              | 1      | 1         | 0             | 1              | 0      | 3         | 1       | 8              |  |  |  |  |
| 6               | 0      | 3         | 0       | 6              | 2              | 2         | 0       | 8              | 2      | 0              | 2       | 1              | 1      | 2         | 0             | 8              | 1      | 0         | 1       | 7              |  |  |  |  |
| 7               | 1      | 0         | 0       | 0              | 3              | 0         | 0       | 8              | 2      | 2              | 1       | 4              | 1      | 3         | 1             | 9              | 1      | 1         | 1       | 8              |  |  |  |  |
| 8               | 1      | 0         | 2       | 6              | 3              | 2         | 1       | 2              | 3      | 0              | 1       | 0              | 2      | 1         | 0             | 3              | 1      | 2         | 2       | 3              |  |  |  |  |
| 9               | 1      | 1         | 2       | 5              | 4              | 0         | 1       | 8              | 3      | 2              | 1       | 0              | 2      | 2         | 2             | 0              | 2      | 0         | 0       | 1              |  |  |  |  |
| 10              | 1      | 2         | 2       | 9              | 4              | 2         | 2       | 8              | 4      | 0              | 1       | 3              | 3      | 0         | 1             | 2              | 2      | 1         | 1       | 3              |  |  |  |  |
| 11              | 2      | 0         | 0       | 7              | 5              | 1         | 1       | 2              | 4      | 2              | 2       | 0              | 3      | 2         | 0             | 8              | 2      | 3         | 0       | 0              |  |  |  |  |
| 12              | 2      | 1         | 1       | 9              | 5              | 3         | 2       | 9              | 5      | 1              | 0       | 1              | 4      | 0         | 0             | 8              | 3      | 0         | 2       | 0              |  |  |  |  |
| 13              | 2      | 3         | 0       | 6              | 6              | 2         | 2       | 0              | 5      | 3              | 1       | 6              | 4      | 2         | 1             | 2              | 3      | 2         | 1       | 7              |  |  |  |  |
| 14              | 3      | 1         | 0       | 0              | 7              | 1         | 1       | 5              | 6      | 2              | 0       | 6              | 5      | 0         | 2             | 2              | 4      | 0         | 1       | 8              |  |  |  |  |
| 15              | 3      | 2         | 2       | 9              | 8              | 0         | 1       | 5              | 7      | 1              | 0       | 0              | 5      | 3         | 0             | 8              | 4      | 2         | 2       | 6              |  |  |  |  |
| 16              | 4      | 1         | 0       | 6              | 8              | 3         | 1       | 9              | 8      | 0              | 0       | 0              | 6      | 2         | 0             | 0              | 5      | 1         | 1       | 0              |  |  |  |  |
| 17              | 4      | 3         | 2       | 1              | 9              | 2         | 2       | 8              | 8      | 3              | 0       | 5              | 7      | 0         | 2             | 8              | 6      | 0         | 0       | 2              |  |  |  |  |
| 18              | 5      | 2         | 1       | 6              | 10             | 2         | 1       | 1              | 9      | 2              | 1       | 6              | 8      | 0         | 0             | 4              | 6      | 3         | 0       | 2              |  |  |  |  |
| 19              | 6      | 1         | 2       | 2              | 11             | 2         | 0       | 0              | 10     | 2              | 0       | 3              | 8      | 3         | 1             | 7              | 7      | 2         | 1       | 1              |  |  |  |  |
| Total Value.    |        |           |         |                | Total Value.   |           |         |                |        | Total Value.   |         |                |        |           | Total Value.  |                |        |           |         | Total Value.   |  |  |  |  |
| 7   1   0   8   |        |           |         |                | 12   1   2   5 |           |         |                |        | 11   1   2   6 |         |                |        |           | 9   3   0   8 |                |        |           |         | 8   2   0   1  |  |  |  |  |

The third Table for renewing of Leases, is for the Term of 40 Years; it is calculated according to five several Rates of Interest, and in its manner of using differs not from the other, nevertheless an Example will be convenient, which therefore I shall give; as suppose there be 14 Years lapsed or run out in a Lease for 40 Years, What must I give to make up this Lease again, according to those several Rates of Interest signified by the Table? that is, What must I give for 14 Years in Reversion, after 26 *in esse*? Or, What's the present Worth of 14 Years, beginning 26 Years hence? For answer, I find by the Table that the Fine for Renewing 14 Years lapsed.

|    |                    |  |          |
|----|--------------------|--|----------|
|    | Y.Q.M.D. pts.      |  | l. s. d. |
| at | 5 p.c. is 2 3 0 4  | Which by the Table of Red. at 10 l. yearly Rent is | 27 16 8  |
|    | 6 p.c. is 2 0 0 2  |  | 20 3 4   |
|    | 8 p.c. is 1 0 1 3  |  | 11 1 8   |
|    | 10 p.c. is 0 2 1 4 |  | 6 3 4    |
|    | 12 p.c. is 0 1 1 1 |  | 3 8 4    |

The Years *in esse*, as was said before, are valued as a Lease of so many Years, as in a Lease for 40 Years, if 14 Years are run out, then there are 26 *in esse*, whose Value are as a Lease of 26 Years, and may be found by the Table for Purchasing, &c.

The Value of some of the Years in Reversion may be found in this Lease, by the same Rules that they were found by in the foregoing Leases; as if it were required to find the Value of 6 of the 14 Years in Reversion in this Lease of 40 Years, then because 6 wants 8 of 14, I take the Value of 8 Years in Reversion from the Value of 14 in Reversion, and the Remainder is the Value of the 6 Years required, which will make the Lease up to 32 Years.



A Table for the Reduction of the Values given in Years, Quarters, Months, and Decimal Parts of a Month, into Pounds, Shillings, and Pence.

| Yearly<br>Rent. | 3 Quarters | 2 Quarters | 1 Quarter. | 2 Months. | 1 Month. | 1 Dec. part | 2 Dec. part | 3 Dec. part. | 4 Dec. part. | 5 Dec. part. |
|-----------------|------------|------------|------------|-----------|----------|-------------|-------------|--------------|--------------|--------------|
|                 | l. s. d.   | l. s. d.   | l. s. d.   | l. s. d.  | l. s. d. | l. s. d.    | l. s. d.    | l. s. d.     | l. s. d.     | l. s. d.     |
| 1               | 0 15 0     | 0 10 0     | 0 0 0      | 0 3 4     | 0 1 8    | 0 0 2       | 0 0 4       | 0 0 6        | 0 0 8        | 0 0 10       |
| 2               | 1 10 0     | 1 0 0      | 0 15 0     | 0 6 8     | 0 3 4    | 0 0 4       | 0 0 8       | 0 1 0        | 0 1 4        | 0 1 8        |
| 3               | 2 5 0      | 1 10 0     | 0 15 0     | 0 10 0    | 0 5 0    | 0 0 6       | 0 1 0       | 0 1 6        | 0 2 0        | 0 2 6        |
| 4               | 3 0 0      | 2 0 0      | 1 0 0      | 0 13 4    | 0 6 8    | 0 0 8       | 0 1 4       | 0 2 0        | 0 2 8        | 0 3 4        |
| 5               | 3 15 0     | 2 10 0     | 1 5 0      | 0 16 8    | 0 8 4    | 0 0 10      | 0 1 8       | 0 2 6        | 0 3 4        | 0 4 2        |
| 6               | 4 10 0     | 3 0 0      | 1 10 0     | 1 0 0     | 0 10 0   | 0 1 0       | 0 2 0       | 0 3 0        | 0 4 0        | 0 5 0        |
| 7               | 5 5 0      | 3 10 0     | 1 15 0     | 1 3 4     | 0 11 8   | 0 1 2       | 0 2 4       | 0 3 6        | 0 4 8        | 0 5 10       |
| 8               | 6 0 0      | 4 0 0      | 2 0 0      | 1 6 8     | 0 13 4   | 0 1 4       | 0 2 8       | 0 4 0        | 0 5 4        | 0 6 8        |
| 9               | 6 15 0     | 4 10 0     | 2 5 0      | 1 10 0    | 0 15 0   | 0 1 6       | 0 3 0       | 0 4 6        | 0 6 0        | 0 7 6        |
| 10              | 7 10 0     | 5 0 0      | 2 10 0     | 1 13 4    | 0 16 8   | 0 1 8       | 0 3 4       | 0 5 0        | 0 6 8        | 0 8 4        |
| 20              | 15 0 0     | 10 0 0     | 5 0 0      | 3 6 8     | 1 13 4   | 0 3 4       | 0 6 8       | 0 10 0       | 0 13 4       | 0 16 8       |
| 30              | 22 10 0    | 15 0 0     | 7 0 0      | 5 0 0     | 2 10 0   | 0 5 0       | 0 10 0      | 0 15 0       | 1 0 0        | 1 5 0        |
| 40              | 30 0 0     | 20 0 0     | 10 0 0     | 6 13 4    | 3 6 8    | 0 6 8       | 0 13 4      | 1 0 0        | 1 6 8        | 1 13 4       |
| 50              | 37 10 0    | 25 0 0     | 12 10 0    | 8 6 8     | 4 3 4    | 0 8 4       | 0 16 8      | 1 5 0        | 1 13 4       | 2 1 8        |
| 60              | 45 0 0     | 30 0 0     | 15 0 0     | 10 0 0    | 5 0 0    | 0 10 0      | 1 0 0       | 1 10 0       | 2 0 0        | 2 10 0       |
| 70              | 52 10 0    | 35 0 0     | 17 10 0    | 11 13 4   | 5 16 8   | 0 11 8      | 1 3 4       | 1 15 0       | 2 6 8        | 2 18 4       |
| 80              | 60 0 0     | 40 0 0     | 20 0 0     | 13 6 8    | 6 13 4   | 0 13 4      | 1 6 8       | 2 0 0        | 2 13 4       | 3 6 8        |
| 90              | 67 10 0    | 45 0 0     | 22 10 0    | 15 0 0    | 7 10 0   | 0 15 0      | 1 10 0      | 2 5 0        | 3 0 0        | 3 15 0       |
| 100             | 75 0 0     | 50 0 0     | 25 0 0     | 16 13 4   | 8 6 8    | 0 16 8      | 1 13 4      | 2 10 0       | 3 6 8        | 4 3 4        |
| 200             | 150 0 0    | 100 0 0    | 50 0 0     | 33 6 8    | 16 13 4  | 1 13 4      | 3 6 8       | 5 0 0        | 6 13 4       | 8 6 8        |
| 300             | 225 0 0    | 150 0 0    | 75 0 0     | 50 0 0    | 25 0 0   | 2 10 0      | 5 0 0       | 7 10 0       | 10 0 0       | 12 10 0      |
| 400             | 300 0 0    | 200 0 0    | 100 0 0    | 66 13 4   | 33 6 8   | 3 6 8       | 6 13 4      | 10 0 0       | 13 6 8       | 16 13 4      |
| 500             | 375 0 0    | 250 0 0    | 125 0 0    | 83 6 8    | 41 13 4  | 4 3 4       | 8 6 8       | 12 10 0      | 16 13 4      | 20 16 8      |
| 600             | 450 0 0    | 300 0 0    | 150 0 0    | 100 0 0   | 50 0 0   | 5 0 0       | 10 0 0      | 15 0 0       | 20 0 0       | 25 0 0       |

The way of purchasing by Lives was commonly to reckon one Life as a Lease of 7 Years, two Lives as a Lease of 14 Years, and three Lives as a Lease of 21 Years: But this way seeming Unequal, there is another way which is more agreeable to Reason, and it is this, viz. for every Life to decrease one Year, as if one Life be reckoned as a Lease for 10 Years, then two will be as a Lease of 19, and three as a Lease of 27 Years, &c. so that at 7*l. per Cent.* one Life is reckon'd worth a little above 7 Years' purchase, two Lives 10 Years, 1 Quarter, and 1 Month's Purchase, &c. as the Table for Purchasing of Lives sheweth.

So if you reckon one Life as a Lease of 9 Years, then two will be as a Lease of 17, three as a Lease of 24, &c. as is evident by the Table; and one Life will be worth above 6 Years and 2 Quarters Purchase, two Lives 9 Years and 3 Quarters Purchase, three Lives 11 Years, 1 Quarter, 2 Months, and 6 Decimal parts Purchase, &c.

So if one single Life be reckoned as a Lease of 12 Years, then two will be as a Lease of 23, three as a Lease of 33 Years, &c. so that at 6 *per Cent.* one Life is worth above 8 Years and a Quarter's Purchase, two Lives above 12 Years and a Quarter's Purchase, &c. as the Table shews.

Now suppose any of those Persons which have their Lives upon an Estate should die, to take in others to make up the Number again, is done by the Table of *Reversions* at the beginning of the

Book: Example, Suppose there be three Lives upon an Estate, which at 7 Years Purchase for the first Life, are valued at almost 12 Years Purchase, and as a Lease of 27 Years, at 7*l. per Cent.* and if one of those Persons should die, what must be given to make up the Number again? Then I say, one Life which is dead was a Lease of 10 Years, and therefore to take in a New Life, I may reckon 10 Years of the 27 lapsed, and so take, as it were, a Fine for renewing 10 Years lapsed in a Lease of 27 Years: Now to find this Fine, I take the Sum of the Reversions for 10 Years in the Table under 7*l. per Cent.* counting 27 as 1, 26 as 2, and 25 as 3, &c. And so I find the Sum to be 2*l.* 4*s.* 5*d.* 2*q.* that is, two Years, and almost one Quarter's Purchase, which I may take for renewing or taking in a new Life: So if two Lives be dead, I may reckon 19 Years lapsed in a Lease of 27 Years, and find the Sum of the Reversions for 19 Years, for a Fine for taking in two Lives: But if there be four Lives upon the Estate, then at 7*l. per Cent.* and at 10 Years for one Life, they will be reckoned as a Lease of 34 Years, and so I must begin at 34 to sum the Reversions; or at 30 if one Life be reckoned as a Lease of 9 Years, and then if one Life be dead, I must reckon 9 Years lapsed in a Lease of 30 Years; if two Lives are dead, I must reckon 17 Years lapsed in the same Lease; and if three are dead I must reckon 24 lapsed: So at 6*l. per Cent.* reckon.



How to buy the Reversion of any Lease or Annuity.

Altho' this may be done by the Table of Reversions, yet I think it will not be amiss, if I shew how it may be done by the Tables of Purchasing also.

Suppose you are to buy the Reversion of a Lease after 6 Years, that is, if it be 6 Years before you commence, what is the present Worth of a Lease suppose of 30 Years at 6 per Centum? Then for Answer look the Value of the whole Lease, which

will be found to be  $\frac{Y. \quad Q. \quad M. \quad D. \quad p.}{13 \quad 3 \quad 0 \quad 1}$

Then find the Value of the 6 Years, which will be  $\frac{4 \quad 3 \quad 2 \quad 0}{}$  Which subtract

The Remainder is the Value of the Reversion required, viz.  $\frac{8 \quad 3 \quad 1 \quad 1}{}$

The Value of the Years lapsed, or in Reversion of any Lease, may also be found by the Table for Purchasing; for the Value of the Years *in esse*, subtracted from the Value of the whole Lease, the remainder is the Value of the Years in Reversion; therefore, suppose in a Lease of 31 Years, there be 12 Years lapsed, what must be given to renew this Lease again at 6 per Cent.? Then I find

the Value of the whole Lease to be  $\frac{Y. \quad Q. \quad M. \quad D. \quad p.}{13 \quad 3 \quad 2 \quad 2}$

And because there are 12 Years lapsed, there are 18 Years *in esse* whose Value is  $\frac{10 \quad 3 \quad 0 \quad 9}{}$

Which subtract

The Remainder is the Value of the Years in Reversion required, viz.  $\frac{3 \quad 0 \quad 1 \quad 3}{}$

| Years | The increase of 1 l. yearly at 6 per Cent. |    |    |    | The Value of 1 l. Annuity to be paid at the end thereof at 6 l. per Cent. |    |    |    | What Annuity 1 l. ready Money will Purchase at 6 l. per Cent. |    |    |    |
|-------|--|----|----|----|---|----|----|----|---|----|----|----|
|       | l.   | s. | d. | q. | l.  | s. | d. | q. | l.  | s. | d. | q. |
| 1     | 1  | 1  | 2  | 1  | 1   | 0  | 0  | 0  | 1   | 1  | 2  | 0  |
| 2     | 1  | 2  | 5  | 2  | 2   | 1  | 2  | 0  | 0   | 10 | 6  | 0  |
| 3     | 1  | 3  | 9  | 3  | 3   | 3  | 8  | 0  | 0   | 7  | 6  | 0  |
| 4     | 1  | 5  | 3  | 0  | 4   | 7  | 5  | 3  | 0   | 5  | 9  | 0  |
| 5     | 1  | 6  | 9  | 0  | 5   | 12 | 8  | 3  | 0   | 4  | 9  | 0  |
| 6     | 1  | 8  | 4  | 1  | 6   | 19 | 6  | 1  | 0   | 4  | 2  | 0  |
| 7     | 1  | 10 | 0  | 3  | 8   | 7  | 10 | 1  | 0   | 3  | 7  | 0  |
| 8     | 1  | 11 | 10 | 2  | 9   | 17 | 11 | 1  | 0   | 3  | 2  | 0  |
| 9     | 1  | 13 | 9  | 1  | 11  | 9  | 9  | 3  | 0   | 2  | 11 | 0  |
| 10    | 1  | 15 | 9  | 3  | 13  | 3  | 7  | 0  | 0   | 2  | 8  | 0  |
| 11    | 1  | 17 | 11 | 2  | 14  | 19 | 5  | 0  | 0   | 2  | 6  | 1  |
| 12    | 2  | 0  | 3  | 0  | 16  | 17 | 4  | 2  | 0   | 2  | 4  | 2  |
| 13    | 2  | 2  | 7  | 3  | 18  | 17 | 7  | 2  | 0   | 2  | 3  | 0  |
| 14    | 2  | 5  | 2  | 2  | 21  | 0  | 3  | 2  | 0   | 2  | 1  | 3  |
| 15    | 2  | 7  | 11 | 0  | 23  | 5  | 6  | 0  | 0   | 2  | 0  | 2  |
| 16    | 2  | 10 | 9  | 2  | 25  | 1  | 5  | 0  | 0   | 1  | 11 | 2  |
| 17    | 2  | 13 | 10 | 0  | 28  | 4  | 3  | 0  | 0   | 1  | 10 | 3  |
| 18    | 2  | 17 | 1  | 0  | 30  | 18 | 1  | 0  | 0   | 1  | 10 | 0  |
| 19    | 3  | 0  | 6  | 0  | 33  | 15 | 2  | 0  | 0   | 1  | 9  | 1  |
| 20    | 3  | 4  | 2  | 0  | 36  | 15 | 8  | 0  | 0   | 1  | 8  | 3  |
| 21    | 3  | 7  | 11 | 3  | 39  | 19 | 10 | 0  | 0   | 1  | 8  | 3  |
| 22    | 3  | 12 | 0  | 3  | 43  | 7  | 10 | 0  | 0   | 1  | 7  | 3  |
| 23    | 3  | 16 | 4  | 2  | 46  | 19 | 10 | 0  | 0   | 1  | 7  | 1  |
| 24    | 4  | 0  | 11 | 2  | 50  | 16 | 3  | 2  | 0   | 1  | 7  | 0  |
| 25    | 4  | 5  | 10 | 0  | 54  | 17 | 3  | 1  | 0   | 1  | 6  | 2  |
| 26    | 4  | 10 | 11 | 3  | 59  | 3  | 1  | 0  | 0   | 1  | 6  | 1  |
| 27    | 4  | 16 | 5  | 1  | 63  | 14 | 1  | 0  | 0   | 1  | 6  | 0  |
| 28    | 5  | 2  | 2  | 3  | 68  | 10 | 6  | 2  | 0   | 1  | 5  | 3  |
| 29    | 5  | 8  | 4  | 0  | 73  | 12 | 9  | 1  | 0   | 1  | 5  | 2  |
| 30    | 5  | 14 | 10 | 0  | 79  | 1  | 2  | 0  | 0   | 1  | 5  | 1  |



The Use of these Tables foregoing is easy, as by Example will appear. *Example* 1. *Suppose* 30 *l.* be put out for 20 Years, what will it amount unto at that time at 6 per Cent. Compound Interest?

Then I look against 20 Years, and find under the Increase of 1 *l.* &c. 3 *l.* 4 *s.* 2 *d.* which shews that 1 *l.* in 20 Years time will increase to 3 *l.* 4 *s.* 2 *d.* which I multiply by 30 thus,

|                         |    |    |    |
|-------------------------|----|----|----|
| 30 times 3 <i>l.</i> is | 90 | 00 | 00 |
| 30 times 4 <i>s.</i> is | 6  | 00 | 00 |
| 30 times 2 <i>d.</i> is | 0  | 5  | 00 |

Sum 96 *l.* 5 *s.* 0 *d.*

That is, 30 *l.* in 20 Years time at 6 per Cent. Compound Interest, will amount to 96 *l.* 5 *s.* 0 *d.*

The Use of the Second is thus, What will an Annuity of 30 *l.* forborn 20 Years amount to in that time? Then for Answer, I look against 20 Years, and under the Value of 1 *l.* Annuity, &c. I find 36 *l.* 15 *s.* 8 *d.* which 36 *l.* 15 *s.* 8 *d.* is the Value of 1 *l.* Annuity forborn 20 Years, then I multiply 36 *l.* 15 *s.* 8 *d.* by 30 *l.* thus,

|                          |      |    |    |
|--------------------------|------|----|----|
| 30 times 36 <i>l.</i> is | 1080 | 00 | 00 |
| 30 times 15 <i>s.</i> is | 22   | 10 | 00 |
| 30 times 8 <i>d.</i> is  | 1    | 00 | 00 |
| Sum                      | 1103 | 10 | 00 |

That is, 36 *l.* Annuity forborn 20 Years will at the End of that Term amount to 1103 *l.* 10 *s.* 0 *d.*

The Use of the Third Table is thus, Suppose a Gentleman hath 300 *l.* by him, with which he's willing to Purchase an Annuity for 20 Years, What Annuity will that Purchase at 6 *l.* per Cent.? For Answer, I look against 20 Years, and find under *What Annuity 1 *l.* ready Money, &c.* 1 *s.* 8 *d.* 3 *q.* which shews, that 1 *l.* ready Money will purchase an Annuity of 1 *s.* 8 *d.* 3 *q.* for 20 Years, which I multiply by 300 *l.* thus,

|                          |    |    |    |
|--------------------------|----|----|----|
| 300 Shillings are        | 15 | 00 | 00 |
| 300 times 8 <i>d.</i> is | 10 | 00 | 00 |
| 300 times 3 <i>q.</i> is | 00 | 18 | 00 |
| Sum                      | 25 | 18 | 00 |

That is, 300 *l.* ready Money will Purchase an Annuity of 25 *l.* 18 *s.* 0 *d.* for 20 Year, at 6 per Cent.

RENITENCY, is that Resistance which there is in Solid Bodies when they press upon, or are impelled one against another, or that Resistance that any heavy Body makes on the account of its Weight, to our Arm or Hand when we lift it up.

RENT, signifies a Sum of Money, or other Consideration issuing yearly out of Lands or Tenements; of which Lawyers reckon three Sorts,

*viz.* *Rent-service*, *Rent-charge*, and *Rent-seck*: *Rent-service*, is where a Man holds his Lands off his Lord by Fealty and certain Rent, or by Fealty Service and certain Rent, or that which a Man making a Lease to another for Term of Years, reserveth yearly to be paid for them. *Rent-charge* is where a Man makes over his Estate to another, by Deed indented, either in Fee, or Fee-tail, or for Term of Life, yet reserves to himself, by the same Indenture, a Sum of Money yearly to be paid to him, with Cause of Distress for Nonpayment. *Rent-seck*, or Dry-Rent, is that which a Man maketh over his Estate by Deed indented, reserveth yearly to be paid to him without Cause of Distress mentioned in the Indenture.

RENTS of *Affise*, were the certain and determined Rents of Ancient Tenants, and were paid in a set Quantity of Money or Provisions: They were so called, because they were *Affised*, and made certain, and so distinguished from *Redditus Mobiles*, or such variable Rents as did rise and fall, like the Corn-rent now reserved to Colleges.

RENTS *Resolute* are accounted among the Fee-Farm-Rents, to be sold by the Statutes of 22 *Car.* 2. c. 6. And are such Rents or Tenths as were anciently payable to the Crown from the Lands of Abbies and Religious Houses: And after their Dissolution, tho' the Lands were demised to others, yet the Rents were still reserved, and made payable to the Crown.

RENVERSE [in *Heraldry*] denotes any Thing set with the Head downwards, as *Chevron renverse*, is a Chevron with the Point downwards, or when a Beast is laid on its Back, *F.* as in the Figure.



RENUENTES [in *Anatomy*] a pair of Muscles of the Head, so called upon account of their being Antagonists to the *Annuentes*, and serve to throw the Head backwards with an Air of refusal.

REPARATIONE *facienda*, is a Writ which lies, in divers Cases, whereof one is, where three are Tenants in Common, or Joint-Tenants, *pro indiviso*, of a Mill or House which is fallen to decay, and the one being willing to repair it, the other two will not; in this Case the Party willing shall have this Writ against the other two.

REPEAT [in *Musick*] a Character shewing that what was last play'd, or sung, must be repeated or gone over again.

REPELLENT *Medicines*, are such Things as by stopping the Heat and Afflux of Humours, and by shutting up the Pores with their cold and binding Qualities, decrease the swelling of a Part, and drive the Humours another way.

REPERCUSSION [in *Musick*] a frequent Repetition of the same Sounds.

REPELLING *Force*: That there is such a thing in Nature, see *Attraction*, towards the End.

REPETITION [a *Figure in Rhetorick*] is when a Person thinking his first Expression not well understood, and is impatient to make his Hearers know what he means, repeats, or explains it another way.

REPLEADER [in *Law*] is to plead against that which was once pleaded before.

REPLEGIARE, signifies properly to redeem a Thing detained or taken by another, by putting in legal Sureties. See *Replevin*.

REPLE-



**REPLEGIARE** *de averiis*, is a Writ brought by one whose Cattle are distrained, or put in the Pound, upon any Cause by another, upon Surety given to the Sheriff to prosecute or Answer the Action in Law.

**REPLETION** [in the *Canon Law*] is where the Revenue of a Benefice is sufficient to fill or occupy the whole Right or Title of the Graduate who holds them.

**REPLEVIN**, is a Writ that lies where a Man is Distrained for Rent or other Thing, then he shall have this Writ to the Sheriff, to deliver to him the Distress, and shall find Surety to pursue his Action against the Distrainer; and if he pursue it not, or if it be found or judged against him, then the Distrainer shall have again the Distress, and he shall have in such Case a Writ called, *Retorno habendo*. Goods may be replevied two Ways, *viz.* by Writ, and that is by the Common Law; or by Plaint, and that is by Statute Law, for the more speedy having again of their Cattle and Goods.

**REPLEVISH**, signifies in our Law the letting any one to *Main Priſe*, upon Surety, 3 E. 1. 11.

**REPLICATION**, is an Exception of the second Degree, made by the Plaintiff, upon the first Answer of the Defendant: It is also, that which the Plaintiff replies to the Defendant's Answer in Chancery, which is either *General* or *Special*.

The *Special* is grounded upon Matter arising out of the Defendant's Answer, &c.

The *General* is so called from the general Words therein used.

**REPORT**, [in *Law*] is a publick Relation of Cases Judicially argued, debated, resolved, or adjudged, in any of the King's Courts of Justice, with the Cause and Reasons of the same delivered by the Judges. Also when the Chancery, or other Court, refer the stating of some Case, or comparing an Account, &c. to a Master of Chancery, or other Referree, his Certificate therein is called, a *Report*.

**REPOSE**, is a Term in *Painting*, signifying the Place where the *Masses*, or great Lights and Shadows are assembled: And this being well understood hinders the Confusion of Objects; suffering not the View to be contracted all together, but to proceed gradually and successively without Disturbance.

**REPOSITION of the Forest**, was an Act whereby certain Forest Lands being made *Purlieu*, upon *View*; were on a *Second View* laid to the Forest again. *Manwood*, pb. 1. p. 178.

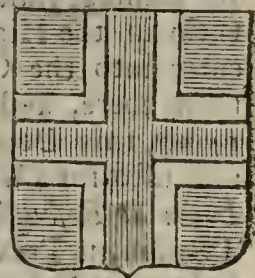
**REPRIZALS**, *Reprisalia*, [in the *Canon Law*] is a Right which Princes have to retake from their Enemies, such Things as they unjustly detain from them, or Thing equivalent to them: Also Letters granted by the Prince to the Subject to do the same.

**REPRISES**, is commonly [in *Law*] taken for Deductions and Duties which are Yearly paid out of a Manor and Lands, as *Rent-charge*, *Rent-seck*, *Pensions*, *Corrodies*, *Annuities*, *Fees of Stewards or Bailiffs*, &c. Wherefore, when we speak of the clear yearly Value of a Manor, we say, it is so much *per Annum ultra Reprisas*, besides all Reprises.

**REPRIEVE** [in *Law*] is properly to take back, or suspend a Prisoner from the Execution and Proceeding of the Law for that time.

**REPTILS**, are all those *Creeping Animals* which rest upon one Part of their Body while they advance the other forward; as *Adders*, *Asps*, *Snakes*, *Earthworms*, &c.

**RESARCELE'E** [in *Heraldry*] as a Cross *Resarcellee* signifies one Cross, as it were, sewed to another; or one Cross placed upon another, or a slenderer Cross charged upon the first, as in the Figure.



**REP-Silver**. The Ancient Servile Tenants were bound to reap their Lord's Corn: But to be acquitted from this Duty, they sometimes paid an Acknowledgement or Composition in Money, which Money was called by this Name of *Rep-Silver*.

**REPULSE**, or *Reaction*. It is one of the Laws of Nature, (Sir Isaac Newton's third) that *Repulse*, or *Reaction*, is always equal to Impulse or Action: that is, The Action of two Bodies one upon another, is always equal, but with a contrary Direction; in other Words, the same Force with which one Body strikes upon another, is returned back by that other on it, and the Forces are impressed with Directions directly contrary. Thus, if one Body press or draw another, 'tis just as much prest or drawn by it: If a Man press a Stone with his Hand, the Stone equally presses his Hand; if a Horse draw forward any Weight by a Rope, the Weight equally draws back the Horse; for the Rope being equally stretch'd both ways, acts upon both equally. So 'tis in all Blows and Strokes, the Thing struck (suppose with a Hammer) strikes the Hammer with equal Force. The Iron draws the Loadstone, as much as the Loadstone draws it; as will appear by Experiments, if you make them both float in Water. Thus also in the Descent of heavy Bodies, the Stone attracts the Earth, as much as the Earth the Stone; or the Earth *gravitates* as much towards the Stone, as it doth towards the Earth. For the Motions produced by both these Gravitations are equal in both; only the Stone being very inconsiderable in respect of the Bulk of the Earth, the velocity of the Earth towards the Stone must be so too, and consequently insensible, in comparison of the motion of the Stone towards it. And so it is universally in all the Actions of Bodies; for if one Body act on another, and change its Motion any manner of way, that other Body will make the same Change in the Motion of this Body, but with a contrary Direction: So that by these Actions there are made equal Changes, not of the *Velocities* but of the *Motion*: For the Changes made on the *Velocities* in contrary Directions, are in a *Reciprocal Proportion to the Bodies*.

**RESCEIT**, is an Admission, or receiving a third Person to plead his Right in a Cause formerly commenced between other two; as if a Tenant for Life or Years bring an Action, he in the Reversion comes in, and prays to be received to defend the Land, and to plead with the Demandant. The Civilians call this, *Admissionem tertii pro suo interesse*.

*Resceit* is also applied to an Admittance of Plea, tho' the Controversy be only between two.

**RESCISION** [in the *Civil Law*] is an Action **RESCISSION** intended for the annulling or setting aside of an Act, Contract, or the like.

**RESCOUS**, or *Rescue*, [in *Law*] is a Resistance against lawful Authority; as if a Bailiff, or other Officer, upon a Writ do Arrest a Man, and others by Violence take him away, or procure his Escape, this is a *Rescous in Fact*: So, if one detain Beasts for



for Damage feasant in his Ground, and as he drives them in the Highway towards the Pound, they enter into the Owner's House, and he withholds them there, and will not deliver them upon Demand, this Detainer is a *Rescous in Law*. It is also used for a Writ which lies for this Fact, called *Breve de Rescussu*. *Rescous*, in Matters relating to Treason, is Treason; and in Matters concerning Felony, is Felony.

RESCUSSOR, is he that commits such a *Rescous*.

RESCRIPT, [in the *Civil Law*] is a Letter of the Emperor in answer to particular Persons who enquire the Law of him: But if it be sent to a Corporation, or any Publick Body of Men who have consulted him, then they call it a *Pragmatick Sanction*.

RESEARCHING [in *Sculpture*] is the repairing of a Cast Figure, with proper Tools; or the finishing it with Art and Exactness, so that the minutest Parts may be well defined.

RESERVATION [in *Law*] signifies a Keeping or Providing; as when a Man lets his Land, he reserves a Rent to be paid to himself for his Maintenance. Sometimes it signifies as much as an *Exception*; as when a Man lets a House, and reserves to himself one Room, that Room is excepted out of the Demise.

RESEISER, is taking (or resumming) of Lands again into the Hands of the King, whereof a general *Livery*, or *Ouster le Main*, was formerly misused, contrary to the Order and Form of Law: *Stanif. Prerog.* 26. See *Resumption*.

RESET [in *Law*] the receiving or harbouring an Outlawed Person.

RESIANCE, or *Residence*, signifies a Man's Abode or Continuance in one Place: And it is all one indeed with *Residence*; but that Custom ties this only to Persons Ecclesiastical.

RESIDENCE, is a Word peculiarly used both in the Common and Canon-Law, for the Continuance or Abode of a Parson or Vicar upon his Benefice.

RESIDUAL *Figure*, in Geometry, signifies the remaining Figure after Subtraction of a lesser from a greater.

RESIDUAL *Root* [in *Mathematicks*] is one composed of two Parts or Members only connected together with the Sign —: Thus  $a - b$ , or  $5 - 3$ , is a *Residual Root*; and is so called, because its true Value is no more than its *residue* or difference between the Parts  $a$  and  $b$ .

RESIGNATION, is a Word used for the giving up of a Benefice into the Hands of the Ordinary, otherwise by the *Canonists* termed *Renunciation*: And though it signifies all one in Nature with the Word *Surrender*, yet it is by Custom restrained to the yielding up a Spiritual Living, and *Surrender* to the giving up of Temporal Lands into the Hands of the Lord.

RESIGNEE [in *Law*] the Party to whom a Thing is resigned.

RESINA, [in *Pharmacy* and *Botany*,] is a fat and oleaginous Liquor flowing either Spontaneously, or else let out by Incision from any Tree or Plant. It will not dissolve in Water, but in Oil only; and is easily inflammable.

RESINE, or *Rosine*, of Jalap, Benjamin, Scammony, Turbith, &c. or of any Vegetable which abounds with Resinous Particles, is thus made in Chymistry.

The Vegetable grossly Powdered, is put into a

Matrafs, and then well rectified Spirit of Wine is poured on it to the Height of four Fingers above the Matter; then another Matrafs hath its Neck fitted and luted into the former to make a double Vessel; and thus the Matter is digested for three or four Days in a Sand Heat, or till it hath given a good Tincture to the Spirit of Wine: Then the Dissolution is filtrated; and two Thirds of the clear Liquor is evaporated off, the Remainder is poured into a large Vessel of Water, and it will turn into a Milk, and the *Resine* will in time precipitate to the Bottom in a white Powder. It must be wash'd and dry'd in the Sun, and it will grow hard like common *Rosin*.

RESISTENCE of the *Medium*, is the Opposition against, or Hindrance of the Motion of any Body moving in a Fluid; as in the Air, the Water, the Æther, &c. And *this*, together with the Gravity of Bodies, is the Cause of the Cessation of the Motion of Projectiles, &c. This *Resistance*, in Mediums which are very dense and rigorous, so that Bodies can there move but very slowly, is nearly as the Velocity of the moving Body: But in a Medium free from all such Rigor, as the Squares of the Velocities, *Newt. Princip.* P. 245. For by the Action of a swifter Body, there is communicated to the same Quantity of the Medium, a greater Motion, in Proportion to that greater Swiftness or Velocity; and therefore in an equal Time, (by reason of the greater Quantity of the Medium being moved) the Motion will be communicated in a duplicate Ratio: But the Resistance must always be as the Motion communicated, because Action and Reaction are equally contrary.

He found also the Thing to be true by Experiment, in a Pendulum of 10 Feet in Length; that the Resistance against a Globe or Ball moving swiftly in our Air, is nearly in a duplicate Ratio of its Velocity: But if it move slower, a little greater than in that Proportion, P. 339.

He found also by making a Lead Bullet swing as a Pendulum in a Vessel of Water, that the Resistance of Water in Proportion to Air, is as 535 to  $\frac{1}{1125}$ .

Dr. Wallis hath an entire Discourse on this Subject in *Phil. Trans.* N<sup>o</sup>. 186, where he premises as a *Lemma*, That supposing all other Things equal, the Resistance of Bodies is always proportionable to the Velocity; since in a double Degree of Velocity there is twice as much Air to be moved in the same time, &c.

As to the different Resistences which Bodies of different Figures will find in passing through any Medium, Sir Is. Newton proves, *Prop.* 34. *Theor.* 28.

That if a Globe and Cylinder with equal Diameters be moved according to the Direction of the Axis of the Cylinder, that the Globe's Resistance will be but half of the Cylinders.

And in the following Scholium, he shews what kind of Figure revolving round an Axis, will generate a Solid that shall move in any Medium, with the least Resistance; and gives a Hint of the Use that this may be of for *Building of Ships*.

After this, several Investigations of the Figure of a roundish Solid, which should move through a Medium with the least Resistance, were publish'd by the Marquis *Hospital*, *Bernoulli*, and very briefly and clearly by Mr. John Craig in the *Phil. Transact.* N. 268. Where he solves the Problem, to determine the Curve, by whose Rotation round an Axis a round Solid shall be generated, which being moved



A Table for the Purchasing of Lives.

| What they are worth at 7l. per Cent. |        |           |         |             | What they are worth at 7l. per Cent. |        |           |         |             | What they are worth at 6l. per Cent. |        |           |         |             |
|--------------------------------------|--------|-----------|---------|-------------|--------------------------------------|--------|-----------|---------|-------------|--------------------------------------|--------|-----------|---------|-------------|
| Number of Years.                     | Years. | Quarters. | Months. | Dec. parts. | Number of Years.                     | Years. | Quarters. | Months. | Dec. parts. | Number of Years.                     | Years. | Quarters. | Months. | Dec. parts. |
| 10                                   | 7      | 0         | 0       | 3           | 9                                    | 6      | 2         | 0       | 2           | 12                                   | 8      | 1         | 1       | 6           |
| 19                                   | 10     | 1         | 1       | 0           | 17                                   | 9      | 3         | 0       | 1           | 23                                   | 12     | 1         | 0       | 6           |
| 27                                   | 11     | 3         | 2       | 6           | 24                                   | 11     | 1         | 2       | 6           | 33                                   | 14     | 1         | 2       | 6           |
| 34                                   | 12     | 3         | 1       | 1           | 30                                   | 12     | 1         | 1       | 8           | 42                                   | 15     | 0         | 2       | 7           |
| 40                                   | 13     | 2         | 0       | 9           | 35                                   | 12     | 3         | 2       | 2           | 50                                   | 15     | 2         | 2       | 7           |
| 45                                   | 13     | 2         | 1       | 2           | 39                                   | 13     | 1         | 0       | 1           | 57                                   | 16     | 0         | 0       | 8           |
| 49                                   | 13     | 3         | 0       | 2           | 42                                   | 13     | 1         | 2       | 4           | 63                                   | 16     | 0         | 2       | 8           |
| 52                                   | 13     | 3         | 1       | 3           | 44                                   | 13     | 2         | 0       | 6           | 68                                   | 16     | 1         | 1       | 2           |
| 54                                   | 13     | 3         | 1       | 6           | 45                                   | 13     | 2         | 1       | 2           | 72                                   | 16     | 1         | 2       | 0           |

reckoning one Life as a Lease of 12 Years, three Lives are as a Lease of 33 Years, and so if one of these Lives be dead, I may reckon 12 Years lapsed in a Lease of 33 Years, if two Lives are dead, I may reckon 23 Years lapsed in the same Lease; and begin at 33 to sum the Reversions, under 6l. per Cent. because the Lives are valued according to the same Rate of Interest. This being understood, it will not be difficult to do the like for any other Number of Lives, and at other Rates of Interest, and Number of Years for one Life; for you may by the Table for purchasing of Leases, &c. make Tables for purchasing of Lives according to what Rate of Interest you think is most convenient; as suppose you reckon one Life as a Lease of 10 Years, and you would have 5l. per Cent. profit, then that will be worth 7 Years and almost 3 Quarters Purchase; but at 8l. per Cent. it is worth but 6 Years and almost 3 Quarters Purchase, &c.

The Table for Purchasing is calculated for several Rates of Interest, that so the Purchaser may use that which is most convenient for him, as in purchasing of Freehold Land, 5l. per Cent. may be enough, but for Copyhold or Leases of Land 6l. per Cent. for Leases of Land and good Houses 8l. per Cent. and for Leases of ordinary Houses 10l. or 12l. per Cent.

The Use of the Table is very plain and easy, as by Example will appear, viz.

Example.

What is a Lease or Annuity of 20 Years worth at 5, 6, 8, 10, or 12 per Cent. per Annum?

| Y. Q. M. D. pts. |          | l. s. d. |     |
|------------------|----------|----------|-----|
| 5                | 12 1 2 5 | 249      | 3 4 |
| 6                | 11 1 2 6 | 229      | 6 8 |
| 8                | 9 3 0 8  | 196      | 6 8 |
| 10               | 8 2 0 1  | 170      | 3 4 |
| 12               | 7 1 2 6  | 149      | 6 8 |

Which at 20l. per An. Rent is

To increase the Number of Years in a Lease do thus: Suppose a Landlord would make a Lease of Land up to 40 Years, wherein his Tenant hath 20 Years to come, what is it worth? Then I say,

| Y. Q. M. D. p.                              |          |
|---|----------|
| A Lease for 4 Years at 6 per Cent. is worth | 15 0 0 3 |
| 20 Years at the same Rate are worth         | 11 1 2 6 |
| Which subtract                              |          |
| The Remainder is                            | 3 2 0 7  |

Which is the Fine to be given to make the Lease up to 40 Years.

To buy a Lease which is not to begin until your old Lease is out; as thus, suppose a Man's Lease is out within 4 Years, and he desires to have a New Lease of 21 Years, to begin when his 4 Years are out, what is this Lease worth in ready Money?

For Answer, I add 4 Years, which is the Time he hath in his old Lease, and 21 together, the Sum is 25, then I find the Worth of these 25 Years, and subtract from it the Value of the 4 Years, the Remainder is the Value of the said Lease in ready Money.

Example.

| Y. Q. M. D. p.  |          |
|---|----------|
| A Lease for 25 Years at 6l. per Cent. is worth                        | 12 3 0 3 |
| The 4 Years at the same Rate are worth                                | 3 1 2 6  |
| Which subtract  |          |
| The Remainder is the Value of the Lease in ready Money required, viz. | 9 1 0 7  |



A Table shewing how many Years, Quarters, Months, and Decimal Parts of a Month's Purchase, any Annuity or Lease of any Land or House is worth, according to several Rates of Interest, viz. according to 5, 6, 8, 10 and 12 per Cent.

| Number of Years<br>to be Purchased. | 5 per Cent. |           |         |                | 6 per Cent.    |           |         |                | 8 per Cent.    |           |         |                | 10 per Cent.   |           |         |                | 12 per Cent.  |           |         |                |
|-------------------------------------|-------------|-----------|---------|----------------|----------------|-----------|---------|----------------|----------------|-----------|---------|----------------|----------------|-----------|---------|----------------|---------------|-----------|---------|----------------|
|                                     | Years.      | Quarters. | Months. | Decimal Parts. | Years.         | Quarters. | Months. | Decimal Parts. | Years.         | Quarters. | Months. | Decimal Parts. | Years.         | Quarters. | Months. | Decimal Parts. | Years.        | Quarters. | Months. | Decimal Parts. |
| 1                                   | 0           | 3         | 2       | 4              | 0              | 3         | 2       | 3              | 0              | 3         | 2       | 1              | 0              | 3         | 2       | 9              | 0             | 3         | 1       | 7              |
| 2                                   | 1           | 3         | 1       | 3              | 1              | 3         | 1       | 0              | 1              | 3         | 0       | 4              | 1              | 2         | 2       | 8              | 1             | 2         | 2       | 3              |
| 3                                   | 2           | 2         | 2       | 6              | 2              | 2         | 2       | 1              | 2              | 2         | 0       | 9              | 2              | 1         | 2       | 8              | 2             | 1         | 1       | 8              |
| 4                                   | 3           | 2         | 0       | 5              | 3              | 1         | 2       | 6              | 3              | 1         | 0       | 7              | 3              | 0         | 2       | 0              | 3             | 0         | 0       | 5              |
| 5                                   | 4           | 1         | 1       | 0              | 4              | 0         | 2       | 5              | 3              | 3         | 2       | 8              | 3              | 3         | 0       | 5              | 3             | 2         | 1       | 2              |
| 6                                   | 5           | 0         | 0       | 9              | 4              | 3         | 2       | 0              | 4              | 2         | 1       | 5              | 4              | 1         | 1       | 2              | 4             | 0         | 1       | 3              |
| 7                                   | 5           | 3         | 0       | 4              | 5              | 2         | 1       | 0              | 5              | 0         | 2       | 4              | 4              | 3         | 1       | 4              | 4             | 2         | 0       | 7              |
| 8                                   | 6           | 1         | 2       | 5              | 6              | 0         | 2       | 5              | 5              | 3         | 0       | 0              | 5              | 1         | 1       | 0              | 5             | 3         | 2       | 6              |
| 9                                   | 7           | 0         | 1       | 3              | 6              | 3         | 0       | 6              | 6              | 1         | 0       | 0              | 6              | 3         | 0       | 1              | 6             | 1         | 0       | 9              |
| 10                                  | 7           | 2         | 2       | 6              | 7              | 1         | 1       | 3              | 6              | 2         | 2       | 5              | 6              | 0         | 1       | 7              | 5             | 2         | 1       | 8              |
| 11                                  | 8           | 1         | 0       | 7              | 7              | 3         | 1       | 6              | 7              | 0         | 1       | 6              | 6              | 1         | 2       | 9              | 5             | 3         | 2       | 3              |
| 12                                  | 8           | 3         | 1       | 4              | 8              | 1         | 1       | 6              | 7              | 2         | 0       | 4              | 6              | 3         | 0       | 7              | 6             | 0         | 2       | 3              |
| 13                                  | 9           | 1         | 1       | 7              | 8              | 3         | 1       | 2              | 8              | 3         | 1       | 8              | 7              | 0         | 1       | 2              | 6             | 1         | 2       | 1              |
| 14                                  | 9           | 3         | 1       | 7              | 9              | 1         | 0       | 5              | 9              | 0         | 2       | 9              | 7              | 1         | 1       | 4              | 6             | 2         | 1       | 5              |
| 15                                  | 10          | 1         | 1       | 5              | 9              | 2         | 2       | 5              | 8              | 2         | 0       | 7              | 7              | 2         | 1       | 2              | 6             | 3         | 0       | 7              |
| 16                                  | 10          | 3         | 1       | 0              | 10             | 0         | 1       | 2              | 8              | 3         | 1       | 2              | 7              | 3         | 0       | 8              | 6             | 3         | 2       | 7              |
| 17                                  | 11          | 1         | 0       | 2              | 10             | 1         | 2       | 7              | 9              | 0         | 1       | 5              | 8              | 0         | 0       | 2              | 7             | 0         | 1       | 4              |
| 18                                  | 11          | 2         | 2       | 2              | 10             | 3         | 0       | 9              | 9              | 1         | 1       | 5              | 8              | 0         | 2       | 4              | 7             | 1         | 0       | 0              |
| 19                                  | 12          | 0         | 1       | 0              | 11             | 0         | 1       | 9              | 9              | 2         | 1       | 2              | 8              | 1         | 1       | 3              | 7             | 1         | 1       | 4              |
| 20                                  | 12          | 1         | 2       | 5              | 11             | 1         | 2       | 6              | 9              | 3         | 0       | 8              | 8              | 2         | 0       | 1              | 7             | 1         | 2       | 6              |
| 21                                  | 12          | 3         | 0       | 8              | 11             | 3         | 0       | 1              | 10             | 0         | 0       | 2              | 8              | 2         | 1       | 7              | 7             | 2         | 0       | 7              |
| 22                                  | 13          | 0         | 1       | 9              | 12             | 0         | 0       | 4              | 10             | 0         | 2       | 4              | 8              | 3         | 0       | 2              | 7             | 2         | 1       | 7              |
| 23                                  | 13          | 1         | 2       | 8              | 12             | 1         | 0       | 6              | 10             | 1         | 1       | 4              | 8              | 3         | 1       | 5              | 7             | 2         | 2       | 6              |
| 24                                  | 13          | 3         | 0       | 5              | 12             | 2         | 0       | 5              | 10             | 2         | 0       | 3              | 8              | 3         | 2       | 8              | 7             | 3         | 0       | 4              |
| 25                                  | 14          | 0         | 1       | 1              | 12             | 3         | 0       | 3              | 10             | 2         | 2       | 1              | 9              | 0         | 0       | 9              | 7             | 3         | 1       | 1              |
| 26                                  | 14          | 1         | 1       | 4              | 13             | 0         | 0       | 0              | 10             | 3         | 0       | 7              | 9              | 0         | 2       | 0              | 7             | 3         | 1       | 7              |
| 27                                  | 14          | 2         | 1       | 7              | 13             | 0         | 2       | 5              | 10             | 3         | 2       | 2              | 9              | 0         | 2       | 8              | 7             | 3         | 2       | 3              |
| 28                                  | 14          | 3         | 1       | 7              | 13             | 1         | 1       | 8              | 11             | 0         | 0       | 6              | 9              | 1         | 0       | 6              | 7             | 3         | 2       | 7              |
| 29                                  | 15          | 0         | 1       | 6              | 13             | 2         | 1       | 0              | 11             | 0         | 1       | 9              | 9              | 1         | 1       | 3              | 8             | 0         | 0       | 3              |
| 30                                  | 15          | 1         | 1       | 3              | 13             | 3         | 0       | 1              | 11             | 1         | 0       | 1              | 9              | 1         | 2       | 0              | 8             | 0         | 0       | 6              |
| 31                                  | 15          | 2         | 1       | 1              | 13             | 3         | 2       | 2              | 11             | 1         | 1       | 2              | 9              | 1         | 2       | 7              | 8             | 0         | 1       | 0              |
| 40                                  | 17          | 0         | 1       | 8              | 15             | 0         | 0       | 3              | 11             | 3         | 2       | 0              | 9              | 3         | 0       | 3              | 8             | 0         | 2       | 9              |
| 50                                  | 18          | 1         | 0       | 0              | 15             | 2         | 2       | 7              | 12             | 0         | 2       | 8              | 9              | 3         | 2       | 0              | 8             | 1         | 0       | 6              |
| 60                                  | 18          | 3         | 2       | 2              | 16             | 0         | 2       | 0              | 12             | 1         | 1       | 5              | 9              | 3         | 2       | 6              | 8             | 1         | 0       | 9              |
| 70                                  | 19          | 1         | 1       | 1              | 16             | 1         | 1       | 6              | 12             | 1         | 2       | 3              | 9              | 3         | 2       | 8              | 8             | 1         | 1       | 0              |
| 80                                  | 19          | 2         | 1       | 2              | 16             | 2         | 0       | 1              | 12             | 1         | 2       | 7              | 9              | 3         | 2       | 9              | 8             | 1         | 1       | 0              |
| 90                                  | 19          | 3         | 0       | 0              | 16             | 2         | 1       | 0              | 12             | 1         | 2       | 8              | 9              | 3         | 2       | 9              | 8             | 1         | 1       | 0              |
| Fee Simple.                         |             |           |         |                | Fee Simple.    |           |         |                | Fee Simple.    |           |         |                | Fee Simple.    |           |         |                | Fee Simple.   |           |         |                |
| 20   0   0   0                      |             |           |         |                | 16   2   2   0 |           |         |                | 12   2   0   0 |           |         |                | 10   0   0   0 |           |         |                | 8   1   1   0 |           |         |                |



How to buy the Reversion of any Lease or Annuity.

Altho' this may be done by the Table of Reversions, yet I think it will not be amiss, if I shew how it may be done by the Tables of Purchasing also.

Suppose you are to buy the Reversion of a Lease after 6 Years, that is, if it be 6 Years before you commence, what is the present Worth of a Lease suppose of 30 Years at 6 per Centum? Then for Answer look the Value of the whole Lease, which

will be found to be  $\text{Y. Q. M. D. p. } 13 \ 3 \ 0 \ 1$

Then find the Value of the 6 Years, which will be  $\text{Y. Q. M. D. p. } 4 \ 3 \ 2 \ 0$   
Which subtract

The Remainder is the Value of the Reversion required, viz.  $\text{Y. Q. M. D. p. } 8 \ 3 \ 1 \ 1$

The Value of the Years lapsed, or in Reversion of any Lease, may also be found by the Table for Purchasing; for the Value of the Years *in esse*, subtracted from the Value of the whole Lease, the remainder is the Value of the Years in Reversion; therefore, suppose in a Lease of 31 Years, there be 12 Years lapsed, what must be given to renew this Lease again at 6 per Cent.? Then I find

the Value of the whole Lease to be  $\text{Y. Q. M. D. p. } 13 \ 3 \ 2 \ 2$

And because there are 12 Years lapsed, there are 18 Years *in esse* whose Value is  $\text{Y. Q. M. D. p. } 10 \ 3 \ 0 \ 9$

Which subtract

The Remainder is the Value of the Years in Reversion required, viz.  $\text{Y. Q. M. D. p. } 3 \ 0 \ 1 \ 3$

| Years | The increase of 1 l. yearly at 6 per Cent. |    |    |    | The Value of 1 l. Annuity to be paid at the end thereof at 6 l. per Cent. |    |    |    | What Annuity 1 l. ready Money will Purchase at 6 l. per Cent. |    |    |    |
|-------|--|----|----|----|---|----|----|----|---|----|----|----|
|       | l.   | s. | d. | q. | l.  | s. | d. | q. | l.  | s. | d. | q. |
| 1     | 1  | 1  | 2  | 1  | 1   | 0  | 0  | 0  | 1   | 1  | 2  | 0  |
| 2     | 1  | 2  | 5  | 2  | 2   | 1  | 2  | 0  | 0   | 10 | 6  | 0  |
| 3     | 1  | 3  | 9  | 3  | 3   | 3  | 8  | 0  | 0   | 7  | 6  | 0  |
| 4     | 1  | 5  | 3  | 0  | 4   | 7  | 5  | 3  | 0   | 5  | 9  | 0  |
| 5     | 1  | 6  | 9  | 0  | 5   | 12 | 8  | 3  | 0   | 4  | 9  | 0  |
| 6     | 1  | 8  | 4  | 1  | 6   | 19 | 6  | 1  | 0   | 4  | 2  | 0  |
| 7     | 1  | 10 | 0  | 3  | 8   | 7  | 10 | 1  | 0   | 3  | 7  | 0  |
| 8     | 1  | 11 | 10 | 2  | 9   | 17 | 11 | 1  | 0   | 3  | 2  | 0  |
| 9     | 1  | 13 | 9  | 1  | 11  | 9  | 9  | 3  | 0   | 2  | 11 | 0  |
| 10    | 1  | 15 | 9  | 3  | 13  | 3  | 7  | 0  | 0   | 2  | 8  | 0  |
| 11    | 1  | 17 | 11 | 2  | 14  | 19 | 5  | 0  | 0   | 2  | 6  | 1  |
| 12    | 2  | 0  | 3  | 0  | 16  | 17 | 4  | 2  | 0   | 2  | 4  | 2  |
| 13    | 2  | 2  | 7  | 3  | 18  | 17 | 7  | 2  | 0   | 2  | 3  | 0  |
| 14    | 2  | 5  | 2  | 2  | 21  | 0  | 3  | 2  | 0   | 2  | 1  | 3  |
| 15    | 2  | 7  | 11 | 0  | 23  | 5  | 6  | 0  | 0   | 2  | 0  | 2  |
| 16    | 2  | 10 | 9  | 2  | 25  | 1  | 5  | 0  | 0   | 1  | 11 | 2  |
| 17    | 2  | 13 | 10 | 0  | 28  | 4  | 3  | 0  | 0   | 1  | 10 | 3  |
| 18    | 2  | 17 | 1  | 0  | 30  | 18 | 1  | 0  | 0   | 1  | 10 | 0  |
| 19    | 3  | 0  | 6  | 0  | 33  | 15 | 2  | 0  | 0   | 1  | 9  | 1  |
| 20    | 3  | 4  | 2  | 0  | 36  | 15 | 8  | 0  | 0   | 1  | 8  | 3  |
| 21    | 3  | 7  | 11 | 3  | 39  | 19 | 10 | 0  | 0   | 1  | 8  | 3  |
| 22    | 3  | 12 | 0  | 3  | 43  | 7  | 10 | 0  | 0   | 1  | 7  | 3  |
| 23    | 3  | 16 | 4  | 2  | 46  | 19 | 10 | 0  | 0   | 1  | 7  | 1  |
| 24    | 4  | 0  | 11 | 2  | 50  | 16 | 3  | 2  | 0   | 1  | 7  | 0  |
| 25    | 4  | 5  | 10 | 0  | 54  | 17 | 3  | 1  | 0   | 1  | 6  | 2  |
| 26    | 4  | 10 | 11 | 3  | 59  | 3  | 1  | 0  | 0   | 1  | 6  | 1  |
| 27    | 4  | 16 | 5  | 1  | 63  | 14 | 1  | 0  | 0   | 1  | 6  | 0  |
| 28    | 5  | 2  | 2  | 3  | 68  | 10 | 6  | 2  | 0   | 1  | 5  | 3  |
| 29    | 5  | 8  | 4  | 0  | 73  | 12 | 9  | 1  | 0   | 1  | 5  | 2  |
| 30    | 5  | 14 | 10 | 0  | 79  | 1  | 2  | 0  | 0   | 1  | 5  | 1  |



The Use of these Tables foregoing is easy, as by Example will appear.

The first is this, Suppose 30 *l.* be put out for 20 Years, what will it amount unto in that time at 6 per Cent. Compound Interest?

Then I look against 20 Years, and find under the Increase of 1 *l.* &c. 3 *l.* 4 *s.* 2 *d.* which shews that 1 *l.* in 20 Years time will increase to 3 *l.* 4 *s.* 2 *d.* which I multiply by 30 thus,

|                         |                                      |
|-------------------------|--------------------------------------|
| 30 times 3 <i>l.</i> is | 90 <i>l.</i> 0 <i>s.</i> 0 <i>d.</i> |
| 30 times 4 <i>s.</i> is | 6 0 0                                |
| 30 times 2 <i>d.</i> is | 0 5 0                                |
| <hr/>                   |                                      |
| Sum                     | 96 5 0                               |

That is, 30 *l.* in 20 Years time at 6 per Cent. Compound Interest, will amount to 96 *l.* 5 *s.* 0 *d.*

The Use of the Second is thus, What will an Annuity of 30 *l.* forborn 20 Years amount to in that time? Then for Answer, I look against 20 Years, and under the Value of 1 *l.* Annuity, &c. I find 36 *l.* 15 *s.* 8 *d.* which 36 *l.* 15 *s.* 8 *d.* is the Value of 1 *l.* Annuity forborn 20 Years, then I multiply 36 *l.* 15 *s.* 8 *d.* by 30 *l.* thus,

|                          |           |
|--------------------------|-----------|
| 30 times 36 <i>l.</i> is | 1080 00 0 |
| 30 times 15 <i>s.</i> is | 22 10 0   |
| 30 times 8 <i>d.</i> is  | 1 00 0    |
| <hr/>                    |           |
| Sum                      | 1103 10 0 |

That is, 36 *l.* Annuity forborn 20 Years will at the End of that Term amount to 1103 *l.* 10 *s.* 0 *d.*

The Use of the Third Table is thus, Suppose a Gentleman hath 300 *l.* by him, with which he's willing to Purchase an Annuity for 20 Years, What Annuity will that Purchase at 6 *l.* per Cent.? For Answer, I look against 20 Years, and find under What Annuity 1 *l.* ready Money, &c. 1 *s.* 8 *d.* 3 *q.* which shews, that 1 *l.* ready Money will purchase an Annuity of 1 *s.* 8 *d.* 3 *q.* for 20 Years, which I multiply by 300 *l.* thus,

|                          |          |
|--------------------------|----------|
| 300 Shillings are        | 15 00 0  |
| 300 times 8 <i>d.</i> is | 10 00 0  |
| 300 times 3 <i>q.</i> is | 100 18 9 |
| <hr/>                    |          |
| Sum                      | 25 18 9  |

That is, 300 *l.* ready Money will Purchase an Annuity of 25 *l.* 18 *s.* 9 *d.* for 20 Year, at 6 per Cent.

RENITENCY, is that Resistance which there is in Solid Bodies when they press upon, or are impelled one against another, or that Resistance that any heavy Body makes on the account of its Weight, to our Arm or Hand when we lift it up.

RENT, signifies a Sum of Money, or other Consideration issuing yearly out of Lands or Tenements; of which Lawyers reckon three Sorts,

viz. *Rent-service*, *Rent-charge*, and *Rent-seck*: *Rent-service*, is where a Man holds his Lands of his Lord by Fealty and certain Rent, or by Fealty Service and certain Rent, or that which a Man making a Lease to another for Term of Years, reserveth yearly to be paid for them. *Rent-charge* is where a Man makes over his Estate to another by Deed indented, either in Fee, or Fee-tail, or for Term of Life, yet reserves to himself, by the same Indenture, a Sum of Money yearly to be paid to him, with Cause of Distress for Nonpayment. *Rent-seck*, or Dry-Rent, is that which a Man maketh over his Estate by Deed indented, reserveth yearly to be paid to him without Cause of Distress mentioned in the Indenture.

RENTS of *Affise*, were the certain and determined Rents of Ancient Tenants, and were paid in a set Quantity of Money or Provisions: They were so called, because they were *Affised*, and made certain, and so distinguished from *Redditus Mobiles*, or such variable Rents as did rise and fall, like the Corn-rent now reserved to Colleges.

RENTS *Resolute* are accounted among the Fee-Farm-Rents, to be sold by the Statutes of 22 *Car.* 2. c. 6. And are such Rents or Tenths as were anciently payable to the Crown from the Lands of Abbies and Religious Houses: And after their Dissolution, tho' the Lands were demised to others, yet the Rents were still reserved, and made payable to the Crown.

RENVERSE [in *Heraldry*] denotes any Thing set with the Head downwards, as *Chevron renverse*, is a Chevron with the Point downwards, or when a Beast is laid on its Back, *F.* as in the Figure.



RENUENTES [in *Anatomy*] a pair of Muscles of the Head, so called upon account of their being Antagonists to the *Annuentes*, and serve to throw the Head backwards with an Air of refusal.

REPARATIONE *facienda*, is a Writ which lies, in divers Cases, whereof one is, where three are Tenants in Common, or Joint-Tenants, *pro indiviso*, of a Mill or House which is fallen to decay, and the one being willing to repair it, the other two will not; in this Case the Party willing shall have this Writ against the other two.

REPEAT [in *Musick*] a Character shewing that what was last play'd, or sung, must be repeated or gone over again.

REPELLENT *Medicines*, are such Things as by stopping the Heat and Afflux of Humours, and by shutting up the Pores with their cold and binding Qualities, decrease the swelling of a Part, and drive the Humours another way.

PERCUSSION [in *Musick*] a frequent Repetition of the same Sounds.

REPELLING *Force*: That there is such a thing in Nature, see *Attraction*, towards the End.

REPETITION [a *Figure in Rhetorick*] is when a Person thinking his first Expression not well understood, and is impatient to make his Hearers know what he means, repeats, or explains it another way.

REPLEADER [in *Law*] is to plead against that which was once pleaded before.

REPLEGIARE, signifies properly to redeem a Thing detained or taken by another, by putting in legal Sureties. See *Replevin*.



**REFLEGIARE** *de averiis*, is a Writ brought by one whose Cattle are distrained, or put in the Pound, upon any Cause by another, upon Surety given to the Sheriff to prosecute or Answer the Action in Law.

**REPLETION** [in the *Canon Law*] is where the Revenue of a Benefice is sufficient to fill or occupy the whole Right or Title of the Graduate who holds them.

**REPLEVIN**, is a Writ that lies where a Man is Distrained for Rent or other Thing, then he shall have this Writ to the Sheriff, to deliver to him the Distress, and shall find Surety to pursue his Action against the Distrainer; and if he pursue it not, or if it be found or judged against him, then the Distrainer shall have again the Distress, and he shall have in such Case a Writ called, *Retorno habendo*. Goods may be replevied two Ways, *viz.* by Writ, and that is by the Common Law; or by Plaint, and that is by Statute Law, for the more speedy having again of their Cattle and Goods.

**REPLEVISH**, signifies in our Law the letting any one to *Main-Prise*, upon Surety, 3 *E. 1.* 11.

**REPLICATION**, is an Exception of the second Degree, made by the Plaintiff, upon the first Answer of the Defendant: It is also, that which the Plaintiff replies to the Defendant's Answer in Chancery, which is either *General* or *Special*.

The *Special* is grounded upon Matter arising out of the Defendant's Answer, &c.

The *General* is so called from the general Words therein used.

**REPORT**, [in *Law*] is a publick Relation of Cases Judicially argued, debated, resolved, or adjudged, in any of the King's Courts of Justice, with the Cause and Reasons of the same delivered by the Judges. Also when the *Chancery*, or other Court, refer the stating of some Case, or comparing an Account, &c. to a Master of Chancery, or other Referree, his Certificate therein is called, a *Report*.

**REPOSE**, is a Term in *Painting*, signifying the Place where the *Masses*, or great Lights and Shadows are assembled: And this being well understood hinders the Confusion of Objects; suffering not the View to be contracted all together, but to proceed gradually and successively without Disturbance.

**REPOSITION** of the *Forest*, was an Act where-by certain Forest Lands being made *Purlieu*, upon *View*; were on a *Second View* laid to the Forest again. *Manwood*, ph. 1. p. 178.

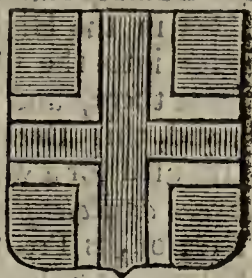
**REPRIZALS**, *Reprisalia*, [in the *Canon Law*] is a Right which Princes have to retake from their Enemies, such Things as they unjustly detain from them, or Thing equivalent to them: Also Letters granted by the Prince to the Subject to do the same.

**REPRISES**, is commonly [in *Law*] taken for Deductions and Duties which are Yearly paid out of a Manor and Lands, as *Rent-charge*, *Rent-seck*, *Pensions*, *Corrodies*, *Annuities*, *Fees of Stewards or Bailiffs*, &c. Wherefore, when we speak of the clear yearly Value of a Manor, we say, it is so much *per Annum ultra Reprisas*, besides all Reprises.

**REPRIEVE** [in *Law*] is properly to take back, or suspend a Prisoner from the Execution and Proceeding of the Law for that time.

**REPTILES**, are all those *Creeping Animals* which rest upon one Part of their Body while they advance the other forward; as *Adders*, *Asps*, *Snakes*, *Earthworms*, &c.

**RESARCELEE** [in *Heraldry*] as a Cross *Resarcellee* signifies one Cross, as it were, sewed to another, or one Cross placed upon another, or a slenderer Cross charged upon the first, as in the Figure.



**REP-Silver**. The Ancient Servile Tenants were bound to reap their Lord's Corn: But to be acquitted from this Duty, they sometimes paid an Acknowledgement or Composition in Money, which Money was called by this Name of *Rep-Silver*.

**REPULSE**, or *Reaction*. It is one of the Laws of Nature, (Sir *Isaac Newton's* third) that *Repulse*, or *Reaction*, is always equal to Impulse or Action: that is, The Action of two Bodies one upon another, is always equal, but with a contrary Direction; in other Words, the same Force with which one Body strikes upon another, is returned back by that other on it, and the Forces are impressed with Directions directly contrary. Thus, if one Body press or draw another, 'tis just as much prest or drawn by it: If a Man press a Stone with his Hand, the Stone equally presses his Hand; if a Horse draw forward any Weight by a Rope, the Weight equally draws back the Horse; for the Rope being equally stretch'd both ways, acts upon both equally. So 'tis in all Blows and Strokes, the Thing struck (suppose with a Hammer) strikes the Hammer with equal Force. The Iron draws the Loadstone, as much as the Loadstone draws it; as will appear by Experiments, if you make them both float in Water. Thus also in the Descent of heavy Bodies, the Stone attracts the Earth, as much as the Earth the Stone; or the Earth *gravitates* as much towards the Stone, as it doth towards the Earth. For the Motions produced by both these Gravitations are equal in both; only the Stone being very inconsiderable in respect of the Bulk of the Earth, the velocity of the Earth towards the Stone must be so too, and consequently insensible, in comparison of the motion of the Stone towards it. And so it is universally in all the Actions of Bodies; for if one Body act on another, and change its Motion any manner of way, that other Body will make the same Change in the Motion of this Body, but with a contrary Direction: So that by these Actions there are made equal Changes, not of the *Velocities* but of the *Motion*: For the Changes made on the *Velocities* in contrary Directions, are in a *Reciprocal Proportion to the Bodies*.

**RESCEIT**, is an Admission, or receiving a third Person to plead his Right in a Cause formerly commenced between other two; as if a Tenant for Life or Years bring an Action, he in the Reversion comes in, and prays to be received to defend the Land, and to plead with the Demandant. The Civilians call this, *Admissionem tertii pro suo interesse*.

*Resceit* is also applied to an Admittance of Plea, tho' the Controversy be only between two.

**RESCISION** & [in the *Civil Law*] is an Action **RESCISSION** intended for the annulling or setting aside of an Act, Contract, or the like.

**RESCOUS**, or *Rescue*, [in *Law*] is a Resistance against lawful Authority; as if a Bailiff, or other Officer, upon a Writ do Arrest a Man, and others by Violence take him away, or procure his Escape, this is a *Rescous in Fact*: So, if one distrain Beasts for



for Damage feasant in his Ground, and as he drives them in the Highway towards the Pound, they enter into the Owner's House, and he withholds them there, and will not deliver them upon Demand, this Detainer is a *Rescous in Law*. It is also used for a Writ which lies for this Fact, called *Breve de Rescussu*. *Rescous*, in Matters relating to Treason, is Treason; and in Matters concerning Felony, is Felony.

RESCUSSOR, is he that commits such a *Rescous*.

RESCRIPT, [in the *Civil Law*] is a Letter of the Emperor in answer to particular Persons who enquire the Law of him: But if it be sent to a Corporation, or any Publick Body of Men who have consulted him, then they call it a *Pragmatick Sanction*.

RESEARCHING [in *Sculpture*] is the repairing of a Cast Figure, with proper Tools; or the finishing it with Art and Exactness, so that the minutest Parts may be well defined.

RESERVATION [in *Law*] signifies a Keeping or Providing; as when a Man lets his Land, he reserves a Rent to be paid to himself for his Maintenance. Sometimes it signifies as much as an *Exception*; as when a Man lets a House, and reserves to himself one Room, that Room is excepted out of the Demise.

RESEISER, is taking (or resumming) of Lands again into the Hands of the King, whereof a general *Livery*, or *Ouster le Maine*, was formerly misused, contrary to the Order and Form of Law: *Stanif. Prerog.* 26. See *Resumption*.

RESET [in *Law*] the receiving or harbouring an Outlawed Person.

RESIANCE, or *Residence*, signifies a Man's Abode or Continuance in one Place: And it is all one indeed with *Residence*; but that Custom ties this only to Persons Ecclesiastical.

RESIDENCE, is a Word peculiarly used both in the Common and Canon-Law, for the Continuance or Abode of a Parson or Vicar upon his Benefice.

RESIDUAL *Figure*, in Geometry, signifies the remaining Figure after Subtraction of a lesser from a greater.

RESIDUAL *Root* [in *Mathematicks*] is one composed of two Parts or Members only connected together with the Sign —: Thus  $a - b$ , or  $5 - 3$ , is a *Residual Root*; and is so called, because its true Value is no more than its *residue* or difference between the Parts  $a$  and  $b$ .

RESIGNATION, is a Word used for the giving up of a Benefice into the Hands of the Ordinary, otherwise by the *Canonists* termed *Renunciation*: And though it signifies all one in Nature with the Word *Surrender*, yet it is by Custom restrained to the yielding up a Spiritual Living, and *Surrender* to the giving up of Temporal Lands into the Hands of the Lord.

RESIGNEE [in *Law*] the Party to whom a Thing is resigned.

RESINA, [in *Pharmacy* and *Botany*,] is a fat and oleaginous Liquor flowing either Spontaneously, or else let out by Incision from any Tree or Plant. It will not dissolve in Water, but in Oil only, and is easily inflammable.

RESINE, or *Rosine*, of Jalap, Benjamin, Scammony, Turbith, &c. or of any Vegetable which abounds with Rosinous Particles, is thus made in Chymistry.

The Vegetable grossly Powdered, is put into a

Matrafs, and then well rectified Spirit of Wine is poured on it to the Height of four Fingers above the Matter; then another Matrafs hath its Neck fitted and luted into the former to make a double Vessel; and thus the Matter is digested for three or four Days in a Sand Heat, or till it hath given a good Tincture to the Spirit of Wine: Then the Dissolution is filtrated; and two Thirds of the clear Liquor is evaporated off, the Remainder is poured into a large Vessel of Water, and it will turn into a Milk, and the *Refine* will in time precipitate to the Bottom in a white Powder. It must be wash'd and dry'd in the Sun, and it will grow hard like common *Rosin*.

RESISTENCE of the Medium, is the Opposition against, or Hindrance of the Motion of any Body moving in a Fluid; as in the Air, the Water, the Æther, &c. And *this*, together with the Gravity of Bodies, is the Cause of the Cessation of the Motion of Projectiles, &c. This *Resistance*, in Mediums which are very dense and rigorous, so that Bodies can there move but very slowly, is nearly as the Velocity of the moving Body: But in a Medium free from all such Rigor, as the Squares of the Velocities, *Newt. Princip.* P. 245. For by the Action of a swifter Body, there is communicated to the same Quantity of the Medium, a greater Motion, in Proportion to that greater Swiftmess or Velocity; and therefore in an equal Time, (by reason of the greater Quantity of the Medium being moved) the Motion will be communicated in a duplicate Ratio: But the Resistance must always be as the Motion communicated, because Action and Re-action are equally contrary.

He found also the Thing to be true by Experiment, in a Pendulum of 10 Feet in Length; that the Resistance against a Globe or Ball moving swiftly in our Air, is nearly in a duplicate Ratio of its Velocity: But if it move slower, a little greater than in that Proportion, P. 339.

He found also by making a Leaden Bullet swing as a Pendulum in a Vessel of Water, that the Resistance of Water in Proportion to Air, is as 535 to  $\frac{1}{11}$ .

Dr. Wallis hath an entire Discourse on this Subject in *Phil. Trans.* N°. 186, where he premises as a *Lemma*, That supposing all other Things equal, the Resistance of Bodies is always proportionable to the Velocity; since in a double Degree of Velocity there is twice as much Air to be moved in the same time, &c.

As to the different Resistences which Bodies of different Figures will find in passing through any Medium, Sir Is. Newton proves, *Prop.* 34. *Theor.* 28.

That if a Globe and Cylinder with equal Diameters be moved according to the Direction of the Axis of the Cylinder, that the Globe's Resistance will be but half of the Cylinders.

And in the following Scholium, he shews what kind of Figure revolving round an Axis, will generate a Solid that shall move in any Medium, with the least Resistance; and gives a Hint of the Use that this may be of for *Building of Ships*.

After this, several Investigations of the Figure of a roundish Solid, which should move through a Medium with the least Resistance, were publish'd by the Marquis *Hospital*, *Bernoulli*, and very briefly and clearly by Mr. John Craig in the *Phil. Transact.* N. 268. Where he solves the Problem, to determine the Curve, by whose Rotation round an Axis a round Solid shall be generated, which being moved







the whole Retardations, which are the Defects of the Arches described in the Liquid, from the Arches to be described *in Vacuo*, or, which is the same, the Difference between the Arches described in the Descent, and the next Ascent; therefore these Differences, if the Vibrations are not very unequal, are nearly as the Squares of the Arches described by the Descent; which is also confirm'd by Experiments in greater Vibrations; for in these the Proportion of Resistance, here considered, obtains.

A Body freely descending in a Fluid, is accelerated by the respective Gravity of the Body, which continually acts upon it, yet not equally, as in a *Vacuum*; the Resistance of the Liquid occasions a Retardation, that is, a Diminution of Acceleration, which Diminution increases with the Velocity of the Body: Now there is a certain Velocity, which is the greatest a Body can acquire by falling; for if its Velocity be such, that the Resistance arising from it becomes equal to the respective Weight of the Body, its Motion can no longer be accelerated; for the Motion here continually generated by the respective Gravity, will be destroy'd by the Resistance, and the Body forc'd to go on equably; a Body continually comes nearer and nearer to this greatest Celerity, but can never attain to it.

When the Densities of a Liquid Body are given, the respective Weight of the Body may be known; and by knowing the Diameter of the Body, it may be found from what Height a Body falling *in Vacuo*, can acquire such a Velocity, as that the Resistance in a Liquid shall be equal to that respective Weight, which will be the greatest Velocity above-mention'd.—If the Body be a Sphere, it is known that a Sphere is equal to a Cylinder of the same Diameter, whose Height is two third Parts of that Diameter; which Height is to be increased in the *Ratio* wherein the respective Weight of the Body exceeds the Weight of the Liquid, in order to have the Height of a Cylinder of the Liquid, whose Weight is equal to the respective Weight of the Body; but if you double this Height, you will have a Height from which a Body falling *in Vacuo*, acquires such a Velocity, as generates a Resistance equal to this respective Weight, and which therefore is the greatest Velocity which a Body can acquire falling in a Liquid from an infinite Height: Lead is eleven times heavier than Water, wherefore its respective Weight is as to the Weight of Water, as 10 to 1: Therefore a Leaden Ball, as it appears, from what has been said, cannot acquire a greater Velocity in falling in Water than it would acquire in falling *in Vacuo*, from an Height of  $13\frac{1}{3}$  of its Diameter.

A Body lighter than a Liquid, and ascending in it by the Action of the Liquid, is moved exactly by the same Laws as an heavier Body falling in the Liquid; wherever you place the Body, it is sustained by the Liquid, and carried up with a Force equal to the Difference of the Weight of the Quantity of the Liquid, of the same Bulk as the Body, from the Weight of the Body: Therefore you have a Force that continually acts equably upon the Body, by which not only the Action of the Gravity of the Body is destroyed, so as that it is not to be considered in this Case, but the Body is also carried upwards by a Motion equably accelerated, in the same manner as a Body heavier than a Liquid descends by its respective Gravity;

but the Equability of the acceleration is destroyed in the same manner by the Resistance, in the ascent of a Body lighter than the Liquid, as it is destroyed in the Descent of a Body heavier.

When a Body specifically heavier than a Fluid is thrown up in it, it is retarded upon a double account; on account of the Gravity of the Body, and on account of the Resistance of the Liquid; consequently a Body rises to a less Height, than it would rise in *Vacuo* with the same Celerities: But the Defects of the Height in a Liquid from the Heights to which a Body would rise *in Vacuo* with the same Celerities, have a greater Proportion to each other than the Heights themselves; and in less Heights, the Defects are nearly as the Squares of the Heights *in Vacuo*.

RESISTENCE of the Air to the Motion of *Projects*. In Phil. Tran. N. 186. There is the Measure of this given very largely and accurately by Dr. Wallis: He lays down at first this *Lemma*. That the Resistance of Bodies is proportional to their Celerity; and then branches out into all the particular Varieties that can well be imagined, and at last computing different Mediums one with another, he concludes their different Resistences to be as their Specific Gravities, obstructed from the Viscidity of the Particles of some Fluids: and also that the specifically heavier Project once in Motion (being equally swift with another that is lighter, &c.) will move through the same Medium more strongly in Proportion to its greater intensive or specific Gravity.

In the *Acta Eruditorum Lipsiæ* for July 1684, Mr. G. G. Leibnitz proposes some New Demonstrations about the Resistences of *Solid Bodies*; which are very Geometrical and Curious.

And in the *Leipsick Acts* for January 1689. He reduces his Thoughts on this Subject into a Dissertation: Entitled, *A Discourse concerning the Resistance of Mediums, and the Motion of Projects in resisting Mediums*.

As to the *Geometrical Considerations* of the Resistance of Bodies of different Figures in one and the same Medium; Mr. James Bernoulli in the *Acta Lipsiæ* for May 1693. gives these Rules.

1. If an *Isoles* Triangle be moved in the Fluid according to the Direction of a Line which is Normal to its Base; first with the Vertex foremost, and then with its Base; the Resistences will be of the Legs, and as the Square of the Base, and as the Sum of the Legs.

2. The Resistance of a Square moved according to the Direction of its Side, and of its Diagonal, is as the Diagonal to the Side.

3. The Resistance of a Circular Segment (less than a Semicircle) carried in a Direction perpendicular to its Basis, when it goes with the Base foremost, and when with its Vertex foremost (the same Direction and Celerity continuing, which is all along supposed) is as the Square of the Diameter, to the same less  $\frac{1}{3}$  of the Square of the Base of the Segment.

Cor. Hence the Resistences of a Semi-circle when its Base, and when its Vertex goes foremost, are to one another in a Sesquialteral Ratio.

4. A Parabola moving in the Direction of its Axis, with its Basis, and then its Vertex foremost, hath its Resistences, as the Tangent to an Arch of a Cir-



a Circle whose Diameter is equal to the Parameter, and the Tangent equal to half the Basis of the Parabola.

5. The Resistences of an Hyperbola, or a Semi-Ellipsis; when the Base and when the Vertex goes foremost, may be thus computed: Let it be, as the Sum (or Difference) of the Transverse Axis, and *Latus Rectum*; is to the Transverse Axis: So is the Square of the *Latus Rectum*, to the Square of the Diameter of a certain Circle; in which Circle apply a Tangent equal to half the Basis of the Hyperbola or Ellipsis. Then say again, as the Sum and Difference of the Axis and Parameter, is to the Parameter; so is the aforesaid Tangent to another Right-line. And further, as the Sum (or Difference) of the Axis and Parameter, is to the Axis: So is the circular Ark corresponding to the aforesaid Tangent, to another Arch. This done, the Resistences will be as the Tangent to the Sum (or Difference) of the Right-line thus found, and that Ark last mentioned.

6. In General, the Resistences of any Figure whatsoever going now with its Base foremost, and then with its Vertex, are as the Figures of the Basis to the Sum of all the Cubes of the *Elementa* of the Basis divided by the Squares of the *Elementa* of the Curve Line.

All which Rules he thinks may be of Use in the Fabrick or Construction of Ships, and in perfecting the Art of Navigation universally. As also for determining the Figures of the Bobs of Pendulums for Clocks.

**RES Naturales**: Natural Things are Three; Health, the Causes of Health, and its Effects. Others reckon Seven; as the Elements, Temperaments, Humours, Spirits, Parts, Faculties, Actions; but Elements and Temperaments belong to Natural Philosophy; Humours, Spirits and Parts, are reckoned amongst the Causes of Health, which consist of a good Temperature, and a due Conformation; Faculties and Actions are comprehended under the Effects of Health. *Blanchard*.

**RES Non-naturales**: Things that are not Natural, are Six; Air, Meat and Drink, Motion and Rest, Sleeping and Waking, the Affections of the Mind, Things that are let out of, and Things retained in the Body. They are so called, because that if they exceed their due Bounds, they often occasion Diseases. *Blanchard*.

**RESOLVEND**, a Term in the Extraction of the Square and Cube Roots, &c. signifying that Number which arises from augmenting the Remainder after Subtraction, by drawing down the next Square Cube, &c. and writing it after the said Remainder.

**RESOLUTION** [in *Mathematicks*] is a Method of Invention, whereby the Truth or Falseness of a Proposition, or its Possibility or Impossibility is discover'd, in an Order contrary to that of *Synthesis*, or Composition: For in this analytical Method, the Proposition is proposed as already known, granted, or done; and then the Consequences thence deducible are examined, till at last you come to some known Truth or Falseness, or Impossibility, whereof that which was proposed is a necessary Consequence, and from thence justly conclude the Truth or Impossibility of the Proposition: Which if true, may then be demonstrated in a Synthetical Method. This Method of Resolution consists more in the Judgment,

Penetration, and Readiness of the Enquirer or Artist, than in any particular Rules: Tho' those of *Algebra* are of necessary Use, and a good Treasure of Geometry in his Head will be of great Advantage to him in all manner of Investigations.

**RESOLUTION** [in *Physicks*] is the Reduction of a Body into its original or natural State, by a Dissolution or Separation of its aggregated Parts.

**RESOLUTION** [in *Chymistry*] is the Reduction of a Mass, or mix'd Body, into its component Parts, or first Principles, by a proper *Analysis*.

**RESOLUTION** [in *Musick*] is when a Canon or perpetual Fugue is not written all on the same Line, or in one Part; but all the Voices which are to follow the *Guido*, or first Voice, are written separately, either in *Score*, i. e. in separate Lines, or in separate Parts, with the Pauses that are to be observed by each in the beginning and in the Tone proper to each.

**RESORT**, or *Resort*, is a Law Word, properly used in a Writ of Tail of Coucenage, as *Descent* is in the Writ of Right.

**RESPECTU Computi Vice-Comitis habendo**: Is a Writ for the respiting a Sheriff's Accounts, on just Occasion delivered to the Treasurer and the Barons of the Exchequer. *Regist. fol. 139 & 179*.

**RESPIRATION**, *Ἀναπνοή*, includes both In- and Expiration, and is an alternate Dilatation and Contraction of the Chest, whereby the Air is taken in by the Wind-pipe for the accension of the Blood, and by and by is driven out again with other vaporous Effluvia. The Cause of Respiration does not seem to consist in the dilatation and contraction of the *Thorax*, as is commonly thought, but in the contraction of the *Tunic*, which covers the upper part of the *Oesophagus* and the *Wind-pipe*, as far as its closest Recesses. *Blanchard*.

There are many Opinions about the Uses of Respiration: Some think the chief, if not the sole Design of it, is to cool and temper the Heat of the Blood, and the Heart.

Others will have the Substance of the Air to get by Respiration into the Vessels of the Lungs to the left Ventricle of the Heart, not only thereby to cool the Blood, but also help to generate aerial Spirits. This was the Opinion of *Hippocrates*, *Aristotle*, and *Galen*.

Others take, with more Probability, *Respiration* to serve for the *Ventilation* of the Blood in the Lungs, in its Passage through them, whereby 'tis disburthened of many excrementitious Streams and superfluous Serosities, which are carried off by the Breath in Expiration; so that the Blood may be advantageously depurated, by what is carried off by the Emunctory of the Lungs.

In the *Philos. Transf.* N<sup>o</sup>. 65, there is a very pretty account of the Cause and Manner of *Respiration*, by the Famous *Laur. Bellini*.

**RESPIRATION**. How such Globules of the Blood as by uniting together in the Veins, from others too large for any Secretion, and are therefore necessarily afterwards broken on the Lungs by the Force of Respiration, Dr. Keil shews in his *Animal Secretion*, p. 24, &c. And to estimate the Force by which the Air is thrust out of the Lungs in Expiration, he took a thin Hog's Bladder, which he could easily blow up with the Breath of one Expiration; and having moistened it, that it might neither resist the Air in blowing up, nor the Weights which were laid upon it; he fix'd a small Tube, whose Diameter was  $\frac{1}{16}$  part of an Inch, to the Neck of the Bladder; and then filling



ing the Bladder with Air, he put a Weight of 2 *lb.* 4 *z.* on the Top of it : and repeating the Experiment several Times, he found that this Weight squeezed all the Air out of the Bladder, through the small Tube, in the Space of 25 Vibrations of a Pendulum, swinging Seconds; and by a Calculation which he there gives, he found the Force by which the Air is forced out of the Lungs at every Expiration to be equal to 100 *lb.* Weight : and therefore, *Action and Reaction being equal*, the Pressure of the Air upon the Lungs every Expiration, must be equal to the Pressure of 100 *lb.* Weight. That is, supposing the Gravity of the Air to be always the same, and the Diameter of the *Trachea* the same also in every Expiration. But since we find by the Barometer, that there is 3 Inches difference between the greatest and the least Gravity of the Air, which is the Tenth-part of its greatest Gravity ; there must be likewise the Difference of 10 *lb.* Weight in its Pressure upon the Lungs at one Time more than at another. He thinks no one can doubt but that this Pressure of the Air on the Lungs in breathing, is sufficient to break the Globules of the Blood, and to dissolve all the Cohesions they might contract in their Circulation through the Veins and Arteries. And when the Blood is thus dissolved and thrown out by the Heart into the *Aorta*, 'tis evident that the Re-union of the Particles requires more or less Time, according to their several attractive Powers, even though they all moved with the same Velocity, and in the same Direction.

But neither does this happen, for a Fluid moves through a Cylinder or Conical Vessel (such as the Arteries are) with a greater Velocity at the Axis, than at the Sides. And again, the Blood is thrust into the *Aorta*, by the whole Force of the Heart : and Fluids when they are pressed, press *undequaque* ; by which means the Arteries are dilated, and the Blood moves not only forwards, but likewise presses perpendicular on the Sides of the Arteries : and as the Sides of the Arteries ( being elastick ) return, they press the Blood from them every way, which must produce an Intestine Motion, and so hinder the Attraction of the Particles ; and by this frequent and strong Cohesion of the Particles of the Blood against the Sides of the great Arteries, the Cohesions of the Particles, if any of them happen to unite, will be immediately dissolved. Again, this intestine Motion must greatly increase on the account that many of the Particles of the Blood are elastick : For by this Resistance of the Sides of the Vessels ; they must necessarily hit one against another ; and being elastick, reflect from one another, and so increase the intestine Motion of the Blood.

On this intestine Motion of the Blood its *Heat* depends ; which therefore is every where proportional to the *Impetus* of the Particles against the Sides of the Vessels ; supposing the Elasticity of the Particles every where the same. But the *Impetus* of the Particles against the Sides of the Vessels decreases, as the Sum of the Cavities of the Vessels increases : and consequently where the Sum of the Cavities of the Vessels is greatest, there the intestine Motion of the Blood is least, and the attractive Power of the Particles (*cæteris paribus*) is greatest.

RESPIRE, a Word used in Law, for Delay, Forbearance, or Continuance of Time.

RESPIRE of *Homage*, is the forbearing of *Homage*, which ought first of all to be performed by

the Tenant that holdeth by *Homage* ; and it had the most frequent Use in such as held by Knights Service in *Capite*, who did pay into the *Exchequer* every fifth Term, some small Sum of Money, to be respited the doing of their *Homage*. See the *Stat. 12. Car. 2. cap. 24.* whereby this is taken away as a Charge incident or arising from *Knights Service*.

RESPONSALIS [in Law] he who gives an Answer, is he that appears for another in Court at a Day assigned : As if *Essoigniator* came only to declare the Cause of the Parties Absence, whether Demandant or Tenant ; and *Responsalis* came for the Tenant, not only to excuse his Absence, but also signify, what Trial he meant to undergo.

REST, in Musick. See *Pause*.

RESTITUTIO in *Integrum*, is a Writ of Restitution to put a Person into Re-possession of such Lands and Tenements, as those whereof he had been wrongfully disseized.

RESTITUTION, the returning of elastical Bodies forcibly bent to their natural State, is called the *Motion of Restitution*.

RESTITUTION [in Law] signifies the yielding up again, or restoring of any Thing unlawfully taken from another : As also the setting him in Possessions of Lands or Tenements that hath been unlawfully disseized of them.

RESTITUTIONE *extracti ab Ecclesia*, is a Writ to restore a Man to the Church, which he had recovered for his Sanctuary, being suspected of Felony.

RESTITUTIONE *Temporalium*, is a Writ that lies where a Man being elected and confirmed Bishop of any Diocese, hath the King's Royal Assent thereto for the *Recovery of the Temporalities* or Barony of the said Bishoprick ; and it is directed from the King to the Escheator of the County.

RESSAUT [in Architecture] the Effect of a Body that either projects or sinks, *i. e.* stands either more out or in than another ; so as to be out of the Line or Level with it.

REST [in Physics] the Continuance of a Body in the same Place ; or it is continual Application or Contiguity to the same Parts of the ambient or contiguous Bodies.

RESTRAINT, is when any Action is hindered or stopped contrary to Volition or Preference of the Mind.

RESUMMONS [in Law] signifies a *Second Summons*, and Calling of a Man to answer an Action, where the *First Summons* is defeated upon any Occasion, as the Death of the Party, or the like.

RESUMPTION, in a large Sense, signifies the taking again into the King's Hands such Lands or Tenements, as before, upon false Suggestion, or other Error, he had delivered to the Heir, or granted by Letters-Patent to any Man.

RETAINING *Fee*, is the first *Fee* given to any Serjeant or Counsellor at Law, whereby to make him sure that he shall not be on the contrary Part.

RETE *Mirabile*. In those Creatures, that have the *Glandula Pituitaria* large, (as in Calves for Instance) the two Carotid Arteries meeting about the *Sella* of the Wedge-like Bone, presently divide themselves into small Twigs, which being interwoven with (tho' not so numerous) Twigs from the internal Jugular Veins, and also with nervous Fibres from the larger Trunk of the fifth Pair of Nerves, make on each side a notable *Plexus*, called

*Rete*



*Rete Mirabile.* There enter into this *Rete* some Twigs also from the Cervical Arteries; and there pass out of it several Twigs into the *Glandula Pituitaria*. So that in these Creatures that Gland seems to be of the same Use to the *Rete Mirabile*, as the *Glandula Pinealis* is to the *Plexus Choroides*, viz. To separate a serous Matter from the arterial Blood. But in Man (according to most Anatomists) this *Rete* is wholly wanting; so that there passing only sometimes a Twig or two, and sometimes none, from the Trunk it self of the Carotid Artery, into the *Glandula Pituitaria*, that Gland is of less Use in him than in other Creatures that have the *Rete*. Yet Dr *Ridley* affirms, That he never found this *Rete* wanting, or with any Difficulty discoverable in Men, springing from, and lying on the Inside of each Carotid Artery: But confesses, that it is far smaller in them than in Brutes; for which Difference he thus accounts. Brutes by reason of their prone Position, would, but for this *Rete*, be in danger of having their Brains deluged as it were with an over-great Quantity of the influent Blood, and of a Rupture of the Vessels by its violent Ingress, and this Danger is so much the more threatned, by how much the same Cause which brings it into the Brain with that Force is equally as great and effectual to hinder its proportionable return. For the Relief of which Inconvenience, Nature hath contrived a Means for its more easy and safe Descent into the Brain, by turning that one largest Stream of Blood (which through its being pent in one Channel, becomes so rapid) into many more, (by which means the Carotid Trunk above the *Dura Mater* in those Creatures, is very small to what it is beneath; whereas that Artery in Men, &c. hath the same Bigness on both sides the Membrane,) and they not only reticulated and contorted for the more slow and laborious Descent of the Blood; (which Contrivance the Ancients thought was only for a more exact Preparation of the Blood for Animal Spirits) but also many of them by their Insertion into the *Glandula Pituitaria*, attended with small Veins issuing thence, to take off some Part of the Burthen too. And that to the aforesaid Position of several Creatures ought chiefly to be ascribed the Variety of Magnitude of this *Rete* in several of them, its Size in Dogs seems highly to evince; in whom, by reason of their Horizontal Position, being neither so prone as several Brutes who feed on Grass, nor so erect as Man, this *Rete* is found smaller than in the first, and larger than in the last.

**RETENTION**, is a Faculty of the human Mind, whereby in order to a farther Progress in Knowledge, it keeps or retains those *Simple Ideas*, which it before received by *Sensation* or *Reflection*; and this is done two ways. First by keeping the *Idea*, which is brought into the Mind, for some Time actually in *View*, which is called *Contemplation*: And Secondly, by *Reviving* again in our Minds those *Ideas*, which after imprinting have disappeared, or have been as it were laid out of sight: And this we do, when we conceive Heat or Light, Yellow, or Sweet, the Object in which those Qualities are, being removed: And this is called *Memory*; which is as it were the common Store-house of all our *Ideas*. And our *Ideas* being nothing but *actual Perceptions* in the Mind, which cease to be any thing, when there is no Perception of them; this *Laying up* of our *Ideas* in the Repository of the Memory, signifies no more than this: That the Mind hath a Power in many Cases,

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to revive Perceptions which it once had, with this additional Perception annexed to them, *That it hath had them before*. And in this Sense it is, that our *Ideas* are said to be in our Memory; when indeed they are actually no where: But only there is an Ability in the Mind, when it will, to revive them again; and as it were paint them a-new on it self.

**RETICULARIS Plexus**, the same with *Choroides*.

**RECTICULUM**, the same with *Omentum*.

**RETIFORMIS Plexus**. See *Plexus Retiformis*.

**RETIFORMIS Tunica**, is the principal Organ of Sight, being a certain Expansion of the inner Substance of the optic Nerve in the Eye, which is to the Eye like a whited Wall in a dark Chamber, and receives and represents the visible Species that are let in by a Hole as it were into a darkened Room.

**RETINA Tunica**, the same with *Retiformis*.

**RETIRADE** [in *Fortification*] is a kind of Retrenchment made in the Body of a Bastion or other Works, which is to be disputed Inch by Inch, after the first Defences are dismounted. It usually consists of two Faces, which make a Re-entring Angle.

**RETIRED Flank**. See *Flank*.

**RETORT**, is an Instrument or Vessel in Chymistry, commonly of this Figure, used for Distillations of Oils and volatile Salts, and also of acid Spirits.



'Tis sometimes made of Glass, sometimes of Earth, and sometimes of Iron, according to the Nature of the Matter to be distilled, and the Degree of Fire necessary to perform the Operation.

Earthen Retorts are best for the drawing of acid Spirits, because they will bear the utmost Heat, and not melt, as Glass ones sometimes do. Therefore when you are forced to use a Glass Retort in so strong a Fire, it must be *coated* or covered over with *Lute*. See that Word.

There is also another kind of Earthen Retorts, which are flat at the Bottom, and whose Nose or Beak turns upwards, which in great Furnaces are used for the Distillation of acid Spirits; and they have earthen Receivers luted to them.

**RETRACTORES Alarum Nasi**, & *Elevator Labii Superioris*: These Muscles arise broad and fleshy from the fourth Bone of the Upper Jaw, whence descending obliquely, they are soon inserted to the Upper Lip, and *Alæ Nasi*. Their Name shews their Use is to lift up the Nose and Upper Lip.

**RETRAHENS Auriculam**, is a Muscle by some called *Triceps Auris*, because it has sometimes three Beginnings. *M. du Verney* says it is composed of five or six fleshy Fibres, which have their Origination from the Superior and Forepart of the *Apophysis Mastoidea*, and descend obliquely to their Insertion in the Middle of the *Concha Auriculæ*.

**RETRAXIT**, [in the *Law*,] (so called from being the effectual Word in the Entry,) is where the Plaintiff or Defendant comes into Court, and declares he hath *with-drawn* his Suit, and will proceed no further; and this is a Bar of all other Actions of a like or inferior Nature. The Difference between a *Retraxit* and a *Non-suit*, is, that the former supposes the Plaintiff or Defendant to be actually present in Court; whereas a *Non-suit* is upon a Demand made, when he should appear, and he makes default. A *Retraxit* also is a Bar,

5 X x x

but



but not a *Non-suit*; for then he may commence a new Action of the like Nature.

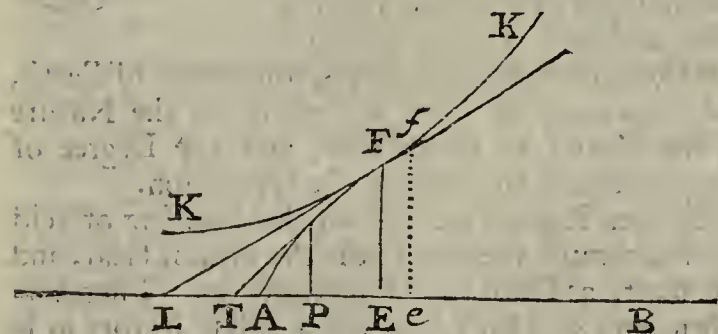
**RETRENCHMENT** [in *Fortification*] is a Ditch bordered with its Parapet, and secur'd with Gabions or Bavins laden with Earth. It is sometimes taken for a simple *Retirade* in Part of the *Rampart*, when the Enemy is so far advanced, that he is no longer to be resisted, or beaten from the first Post.

**RETROCESSION** of the Equinoxes, is the annual going backward of the Equinoctial Points about 50 Seconds. See *Equinoxes*.

**RETROGRADE** [in *Astronomy*] is usually appropriated to the Planets, when by their proper Motion in the Zodiack, they move backward or contrary to the Succession of the Signs: As from the second Degree of *Aries* to the first, &c. But this Retrogradation is only apparent, and occasioned by the Observer's Eye being placed on the Earth: For to an Eye at the Sun, the Planet will appear always direct, and never either Stationary or Retrograde.

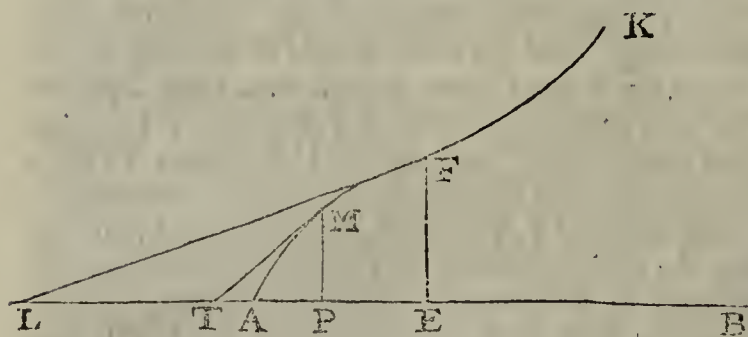
**RETROGRADATION** of a Planet. See an Account of the Reason of this Phænomenon, under the word *Direct*.

**RETROGRESSION** of Curves: The same with what is otherwise called contrary Flexion; and is thus: When a Curve Line *AFK* is partly



concave and partly convex, in respect of the Right Line *AB*, or in respect of the determinate Point *B*; the Point *F* which separates the concave Part of the Curve from the convex, or which is the end of the one, and the beginning of the other, is called the *Point of contrary Flexion*, when the Curve is continu'd from *F* towards the same Side as before. But when the Curve is continu'd backwards towards *A*, then *F* is called the *Point of Retrogression*.

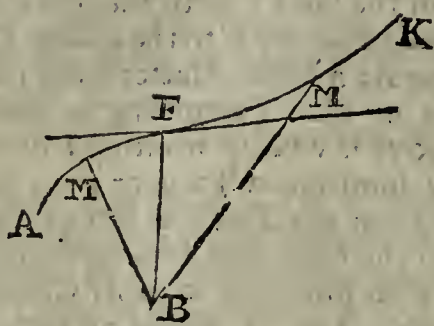
179. If we suppose the Ordinate *PM* to move from *A* towards *B*, and consider the various Af-



fections of the Fluxions thereof, as it moves along, it will be an easy matter to determine the Point of contrary Flexion or Retrogression.

In the first place, let *AB* be the Diameter of the Curve Line *AMK*; and let the Ordinate *PM*, *EF* be parallel between themselves; and draw the

Tangents *MT*, *FL*; then 'tis evident, that in Curves having a Point of contrary Flexion, the



intercepted Diameter encreases continually, and the Portion of the Diameter *AT* intercepted between the Tangent *MT*, and *A* the beginning of the Abscissa increases also, till the point *P* arrive at *E*, and afterwards decreases again; and hence 'tis plain, that the Portion of the Sub-tangent *AT* becomes a *Maximum*, when the points *P* and *M* fall in *E* and *F*.

180. But when the Curve *AMF* is continu'd backwards from *F* towards *A*, then the Sub-tangent *AT* increases continually; but the intercepted Diameter increases only, until the point *T* arrive in *L*, or until the Ordinate *PM* coincides with *EF*; and afterwards it decreases again.

Hence to find a general Form which shall serve to investigate the Points of contrary Flexion and Retrogression.

Suppose *AE* = *x*, *EF* = *y*; then is *AL* =  $\frac{y^2 x}{y^2} - x$ ,

and the Fluxion thereof  $\frac{y^2 \dot{x} - y \dot{y} x}{y^2} - \dot{x}$  must be = 0, and by Transposition, and Division (by  $\dot{x}$ , supposing  $\dot{x}$  an Invariable Quantity)  $\frac{y^2 \dot{x} - y \dot{y} x - y^2 \dot{x}}{y^2} = 0$ , and  $\frac{-y \dot{y} x}{y^2} = 0$ , or

Infinity; and multiplying by  $y^2$  and dividing by  $-y$ , we have  $\dot{y} = 0$ , or Infinity: Which for the future will serve for a General Form to find the points (*F*) of contrary Flexion and Retrogression; for the Nature of the Curve *AFK* being given, if we find the Value of  $\dot{y}$  in  $\dot{x}$ , and again find the Fluxion of that Value (supposing  $\dot{x}$  to be invariable) we shall have the Value of  $\dot{y}$  in  $\dot{x}^2$ , which being put equal to nothing or Infinity, will serve in either of these Suppositions, to find such a Value of *AE*, that the Ordinate *EF* shall intersect the Curve *AFK* in *F* the point of contrary Flexion or Retrogression.

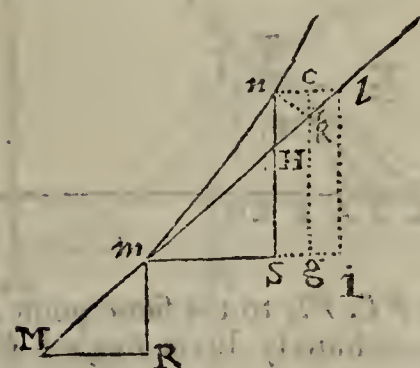
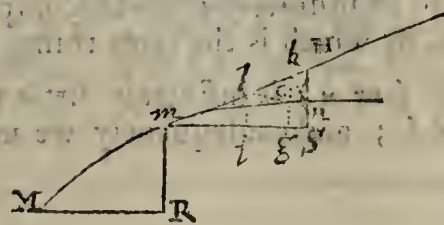
181. The point *A* the beginning of  $\dot{x}$  may be so situated, that *AL* shall be =  $x - \frac{y^2 \dot{x}}{y^2}$  instead of  $\frac{y^2 \dot{x}}{y^2} - x$ , and that *AL* or *AE* may be a *minimum* instead of being a *maximum*, but because the Consequence is still the same, and that this can create no Difficulty, it shall be sufficient to observe,

That *AL* can never be =  $x + \frac{y^2 \dot{x}}{y^2}$ ; for when the point *T* falls on the other Side of *P* in respect of



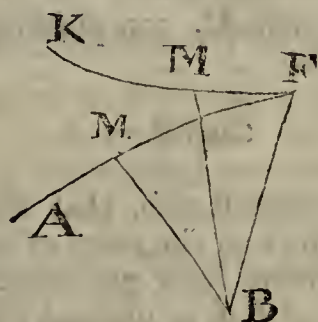
of the begining of  $x$ , then the Value of  $\frac{y\dot{x}}{y}$  will be Negative, and consequently, the Value of  $-\frac{\dot{x}}{y}$  will be Positive, and therefore in such a Case  $AE + EL$  is  $= x - \frac{y\dot{x}}{y}$ .

182. The point of contrary Flexion or Retrogression may be found otherwise, in this manner :

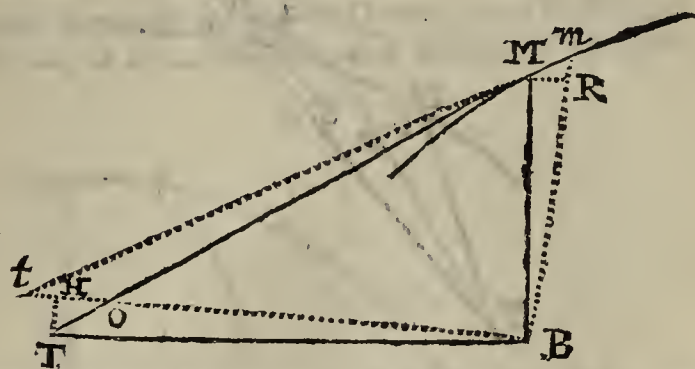


It is evident that if  $\dot{x}$  be supposed invariable, and that the Ordinate  $y$  be a flowing Quantity, then  $Sn$  is less than  $SH$  or  $Rm$ , when the Curve is concave towards the Axis; and  $Sn$  is greater than  $SH$  or  $Rm$ , when the Curve is convex towards the Axis. Whence it follows, that the Value of  $Hn$  or  $\dot{y}$  from being Positive becomes Negative in  $F$ , the point of Inflexion or Retrogression; that is,  $\dot{y}$  is  $= 0$ , or *Infinity*.

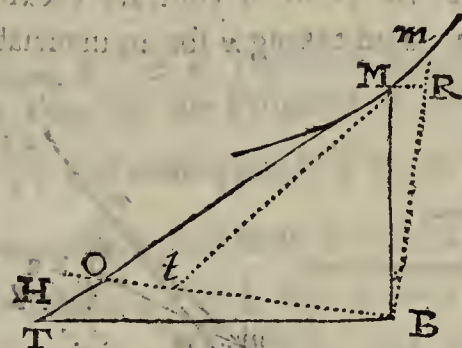
183. And if the Curve  $AFK$  respect a single point  $B$ , then draw the Ordinates  $BM, BF, BM$ , all concurring in the given point  $B$ . Then if you draw any Ordinate as  $BM$ , and the Tangent  $MT$



intersecting  $BT$  perpendicular to  $BM$  in  $T$ , and if the point  $m$  be taken infinitely near to  $M$ , and the Ordinate  $BM$ ,  $Bt$  a Perpendicular thereto, and the Tangent  $mt$  be drawn; 'tis evident (if we suppose the Ordinate  $BM$  to increase as it comes to  $Bm$ ) that in  $F$  the concave Part of the Curve,  $Bt$  surpasses  $Bo$ , ( $o$  being the point where  $MT$  intersects  $Bt$ ) and in the part of the Curve which is convex towards  $B$ ,  $Bt$  is less than  $Bo$ ; whence 'tis manifest that in  $F$  the point of contrary Flexion or Retrogression, the Value of  $Ot$  passes from being Positive to be Negative.



184. These Things being premis'd: If on the Centre  $B$ , and with the Radii  $BT, BM$ , the little Arches  $TH, MR$  be describ'd; then the Triangles



$MRm, MBT$  and  $THO$  are similar, and the little Sectors  $BMR, BTH$  are also similar; whence (supposing  $EM = y, MR = \dot{x}, RM = \dot{y}$ ,)  $mR(\dot{y}) : RM(\dot{x}) :: BM(y) : BT = \frac{y\dot{x}}{y}$   
 $:: MR(\dot{x}) : TH = \frac{\dot{x}^2}{y} :: TH(\frac{\dot{x}}{y}) : HO = \frac{\dot{x}^3}{y^2}$

And if we take the Fluxion of  $BT(\frac{y\dot{x}}{y})$  supposing  $\dot{x}$  to be an Invariable Quantity, then is  $Bt = BT = Ht = \frac{y^2\dot{x} - y\dot{x}\dot{y}}{y^2}$  and  $OH + Ht = \frac{\dot{x}^3 + y^2\dot{x} - y\dot{x}\dot{y}}{y^2}$ . Now because in the

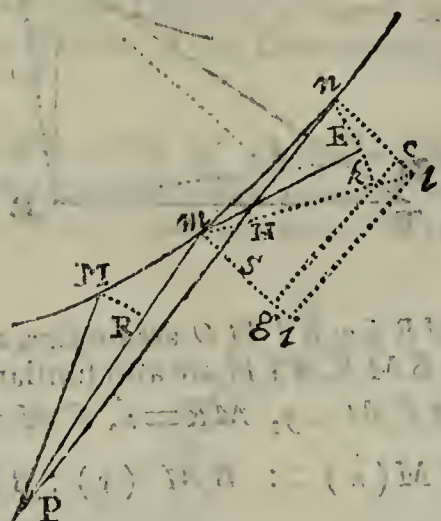
point of contrary Flexion or Retrogression,  $Ot$  is either  $= 0$ , or *Infinity*, therefore in the said point  $\frac{\dot{x}^3 + y^2\dot{x} - y\dot{x}\dot{y}}{y^2}$  is  $= 0$ , or *Infinity*, and multiplying by  $y^2$ , and dividing by  $\dot{x}$ , we have  $\dot{x}^2 + y^2 - y\dot{y} = 0$ , or *Infinity*; whence if the Nature of the Curve  $AFK$  be given, then the Value of  $\dot{y}$  may be found in  $\dot{x}$ , and the Value of  $\dot{y}$  in  $\dot{x}^2$ ; and if the said Values be substituted in the general Form, there will remain one unknown Quantity ( $\dot{x}$ ) and the Equation thus cleared, will serve to find such a Value of  $BF$ , that setting one foot of your Compasses in  $B$ , and with the other, at the Distance  $BF$ , describing a Circle, it will cut the Curve in  $F$ , the point of contrary Flexion or Retrogression; which was required to be done.

185. And to determine the said points another way, it must be observ'd, that in the concave Part,





Part, the Angle  $P m E$ , is greater than the Angle  $P m n$ , and contrarily, in the Convex Part, the Angle  $P m E$  is less than  $P m n$ , and consequently that the Angle  $P m E - P m n = E m n$ , or the Arch  $E n$ , from being Positive becomes Negative in  $F$  the Point of contrary Flexion or Retrogression. And taking  $\dot{x}$  for an invariable Quan-



tity, the right angled Triangles  $H m S$ ,  $H n k$  are similar; therefore  $H m (= \dot{z}) : m S (\dot{x}) ::$

$H n (-\ddot{y}) : n k = -\frac{\dot{x} \ddot{y}}{\dot{z}}$ ; and here it must be observed, that  $H n$  is Negative, because while  $B m (y)$  increases,  $m R (\dot{y})$  decreases. Now because the Sectors  $P m S$ ,  $m E k$  are similar, it is  $B m (y) : m S (\dot{x}) :: m E (\dot{z}) : E k = \frac{\dot{x} \dot{z}}{y}$ ; and therefore  $E k + k n$  is  $= \frac{\dot{x} \dot{z}^2 - y \dot{x} \ddot{y}}{y \dot{z}}$

and multiplying by  $y \dot{z}$ , and dividing by  $\dot{x}$ , we shall have  $\dot{z}^2 - y \ddot{y}$ , or (substituting  $\dot{x}^2 + \dot{y}^2$  for  $\dot{z}^2$ ) because of the right angled Triangle  $m S n$ ,  $\dot{x}^2 + \dot{y}^2 - y \ddot{y}$ , which passes from being Positive to be Negative, in the point of contrary Flexion or Retrogression.

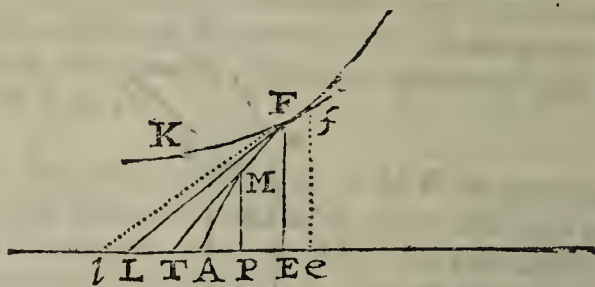
And if we suppose  $y$  to be infinite, then the Terms  $\dot{x}^2$ , and  $\dot{y}^2$  vanish, and are equal to nothing in respect of  $y \ddot{y}$ , and consequently the form  $\dot{x}^2 + \dot{y}^2 - y \ddot{y} = 0$ , or *Infinity*, will become  $-y \ddot{y} = 0$ , or *Infinity*, that is to say, dividing by  $-y$ ,  $\ddot{y} = 0$ , or *Infinity*; which is the Form of the first Case; and this ought to be so, because the Ordinates  $B M$ ,  $B F$ ,  $B M$  are then parallel to one another.

Confectary 1.

186. When  $\ddot{y} = 0$ , then 'tis evident that the Fluxion of  $AL$  is nothing in respect of  $\dot{x}$  the Fluxion of  $AE$ ; and that the two Tangents  $FL$ ,  $fL$  being infinitely near each other, ought to make but one strait Line  $fFL$ .

Confectary 2.

And when  $\ddot{y} = \text{Infinity}$ , then the Fluxion of  $AL$  ought to be infinitely great in Comparison of that of  $AE$ , or which is the same thing, the Fluxion of  $AE$  (or  $\dot{x}$ ) is infinitely little in respect of that of  $AL$ ; and consequently we may draw



two Tangents  $FL$ ,  $Ff$ , to the same point  $F$ , comprehending the infinitely little Angle  $LFf$ .

Confectary 3.

In like manner, when  $\dot{x}^2 + \dot{y}^2 - y \ddot{y} = 0$ , 'tis evident, that  $o t$  ought to be equal to nothing in respect of  $M R$ ; and consequently, that the two Tangents  $MT$ ,  $m t$ , infinitely near each other, must co-incide, when the point  $M$  is the same with the point of contrary Flexion or Retrogression.

Confectary 4

And when  $\dot{x}^2 + \dot{y}^2 - y \ddot{y} = \text{Infinity}$ , then  $o t$  is infinite in respect of  $M R$ , or which is the same thing,  $M R$  is infinitely little in Comparison of  $o t$ , and consequently the points  $M$  and  $m$  must co-incide; that is, when the point  $M$  is the point of Inflexion or Retrogression, we may draw two Tangents through  $M$ , comprehending an Angle infinitely little.

Confectary 5.

Hence it is evident also, that the Line which touches the Curve in the point of contrary Flexion or Retrogression, being prolonged, touches and cuts the Curve  $AFK$  in one and the same point.

PROP. I.

If the Curve Line  $AFK$  be given, and its Diameter  $AB$ ; and if the Relation of the Abscissa  $AE (x)$  to the Ordinate  $EF (y)$  be express'd by this Equation  $a x x = x x y + a a y$ ; 'tis requir'd to find the Value of  $AE$ , so that the corresponding Ordinate  $EF$  shall intersect the Curve  $AFK$  in the point of contrary Flexion  $F$ .

187. The Equation Curve is  $y = \frac{x x}{x x + a a}$  and

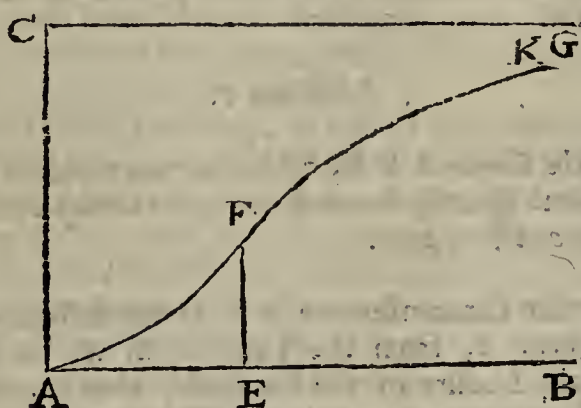


$\dot{y} = \frac{2a^3 \dot{x} x}{xx + aa^2}$ ; and taking the Fluxion of this

Quantity, and supposing  $\dot{x}$  invariable, and putting the said second Fluxion equal to nothing; we

have  $2a^3 x^2 \dot{x} x x + aa^4 - 8a^3 x^2 \dot{x}^2 x x x + aa^4$

$= 0$ , and multiplying by  $xx + aa^2$ , and dividing by  $2a^3 x^2 \dot{x} x x + aa^4$ , we have  $xx + aa^2 = 4x^2 \dot{x} = 0$ . And  $3x^2 \dot{x} = aa^2$ , that is  $x(AE) = a\sqrt{\frac{1}{3}}$ .



If we substitute  $\frac{1}{3}aa$  in place of  $xx$  in the Equation of the Curve  $y = \frac{axx}{xx + aa^2}$ , then  $y = \frac{\frac{1}{3}a^3}{\frac{1}{3}aa + aa^2} = \frac{1}{4}a = EF$ ; so that we may determine the point of Inflexion  $F$ , without supposing the Curve  $AFK$  to be describ'd.

If  $AC$  be drawn parallel to the Ordinate  $EF$ , and equal to the given Line  $a$ , and if  $CG$  be drawn parallel to  $AB$ , it will be an Asymptote to the Curve  $AFK$ . For if we suppose  $x$  to be infinite, then the Equation of the Curve  $y = \frac{axx}{xx + aa^2}$  will become  $y = \frac{axx}{xx} = a$ , so that the Ordinate of the Curve  $EF$  cannot be  $= a$ , before the Abscissa  $AE$  be infinite.

### COROLLARY.

188. If the Equation of the Curve be  $y - a = \frac{x - a^2}{6x^2 - 7}$ , then  $\dot{y} = \frac{\dot{x} - 2a\dot{x}}{6x^2 - 7} = \frac{\dot{x}(1 - 2a)}{6x^2 - 7}$ , and  $\dot{y} =$

(supposing  $\dot{x}$  invariable)  $= \frac{-x - a}{25} \dot{x}^2 =$

$\frac{-6x^2}{25\sqrt{x-a^2}}$ ,  $= 0$ . Then  $-6x^2$  is  $= 0$ ; which because it makes nothing for the Resolution of the

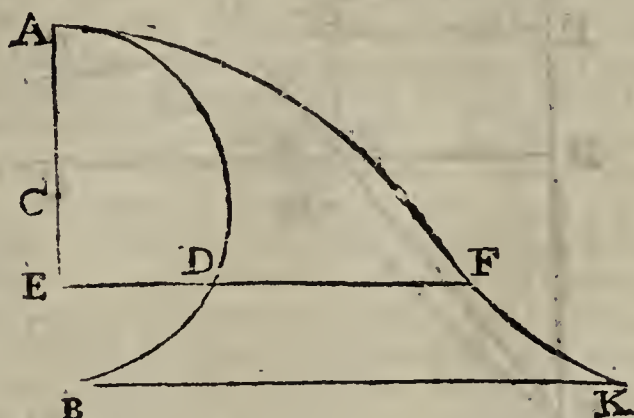
Question, therefore I put  $\frac{-6x^2}{25\sqrt{x-a^2}} = \text{Infinite}$

ly; whence the Denominator  $25\sqrt{x-a^2}$  is  $= 0$ , and consequently, the unknown Quantity  $x(AE)$  is  $= a$ .

### PROP. II.

If  $AFK$  be a protracted Semi-cycloid whose Base  $BK$  is longer than the Semi-circumference of the generating Circle  $ADB$ , whose Centre is  $C$ ; 'tis requir'd to find the point  $E$  in the Diameter  $AB$ , so that the Ordinate  $EF$  shall cut the Semi-cycloid in  $F$  the point of contrary Flexion.

189. Suppose the known Quantities  $ADB = a^2$ ,  $BK = b$ ,  $AB = 2r$ , and the unknown Quanti-



ties  $AE = x$ ,  $ED = z$ , the Arch  $AD = u$ ; and  $EF = y$ ; then by the Property of the Cycloid  $y = z + \frac{bu}{a}$ , and consequently  $\dot{y} = \dot{z} + \frac{b\dot{u}}{a}$ ; but

by the Property of the Circle  $z = \sqrt{2rx - xx}$  and consequently,  $\dot{z} = \frac{1}{2} \times \frac{2r - 2x}{\sqrt{2rx - xx}} = \frac{r - x}{\sqrt{2rx - xx}}$  and  $\dot{u} =$

$\sqrt{\dot{x}^2 + \dot{z}^2} = \frac{r\dot{x}}{\sqrt{2rx - xx}}$ , therefore substituting for  $\dot{z}$  and  $\dot{y}$  their respective Values, we

have  $\dot{y} = \frac{arx - axx}{a\sqrt{2rx - xx}} + \frac{b\dot{u}}{a\sqrt{2rx - xx}}$

$= \frac{arx - axx + brx}{a\sqrt{2rx - xx}}$  and the Fluxion there-

of, (supposing  $x$  invariable) is  $\dot{y} =$

$\frac{br - arr - br^2 x x^2}{2rx - xx \sqrt{2rx - xx}} = 0$ , whence  $brx - arr$

$- br^2 x x^2$  is  $= 0$ ; and dividing by  $x^2 \times r$ , we have  $bx - ar - br = 0$ , and by Transposition

$bx = ar + br$ , and  $x = r + \frac{ar}{b}$ , and consequently  $CE = \frac{ar}{b}$ .

Hence 'tis manifest, that to have a point of contrary Flexion  $F$ ,  $b$  must be greater than  $a$ ; for if  $b$ , be less than  $a$ , then  $CE$  would exceed  $CB$ .

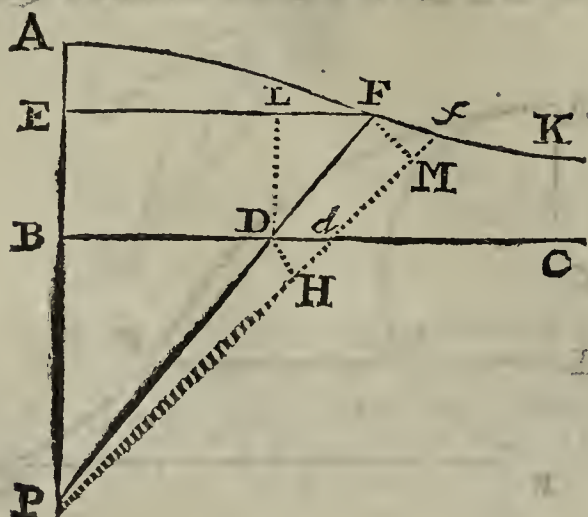
### PROP. III.

Let it be requir'd to find  $F$ , the point of contrary Flexion in Nichomedes's Conchoid  $AFK$ .

190. Let  $BC$  be the Asymptote, and  $P$  the Pole of the Conchoid; then the Property of the Conchoid is, that if you draw strait Lines from the Pole  $P$  to the Curve  $AFK$ , as  $PF, PA$ , then the Segments between the Asymptote and the Curve *v. g.*  $AB, DF$  are always equal to a given Line  $a$ .

Draw  $PA$  perpendicular, and  $FE$  parallel to  $BC$ , and suppose the known Quantities  $AB = FD = a$ ;  $BP = b$ ; and the unknown Quantities  $BE = x$ ,  $EF = y$ , and draw  $DL$  parallel to  $BA$ , then because the Triangles  $DLF, PEF$ , are





are similar; it is  $DL(x) : LF(\sqrt{aa - xx})$   
 $:: P.E(b+x) : FE = y = \frac{b+x\sqrt{aa-xx}}{x}$

and consequently  $\dot{y} = \frac{x^3\dot{x} + aab\dot{x}}{xx\sqrt{aa-xx}}$ . And  $\ddot{y} =$

$$\frac{2a^4b - aax^3 - 3aabbxx\dot{x}}{aa^3 - x^5\sqrt{aa-xx}} = 0, \text{ whence by}$$

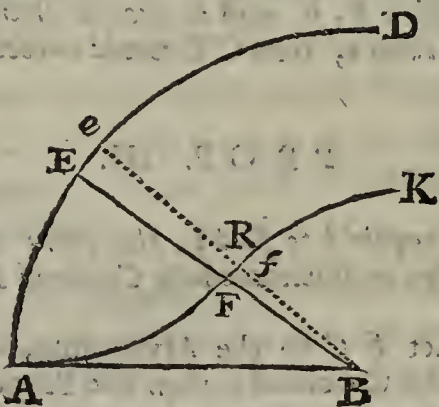
Reduction there will arise  $x^3 + 3bxx - 2aab = 0$ , and one of the Values of the Root  $x$  will be  $= PF$ , which was requir'd.

If  $a$  be  $= b$ , the preceding Equation will be changed into this other,  $x^3 + 3axx - 2a^3 = 0$ , which being divided by  $x + a$  the Quotient is  $xx + 2ax - 2a^2 = 0$ , and consequently  $x$  is  $= -a + \sqrt{3aa}$ .

#### PROP. IV.

Let  $AED$  be an Arch of a Circle, and  $B$  its Centre, and let the Property of the Curve-line  $AFK$  be such, that drawing any Ray  $BFE$  at pleasure, the Square of  $FE$  be equal to the Rect-angle comprehended under the Arch  $AE$  and a given Right Line  $a$ . 'Tis requir'd to find the Point ( $F$ ) of contrary Flexion.

191. Suppose the Arch  $AE = z$ , the Radius  $BA = r$ , and the Ordinate  $BF = y$ ; then by the Property of the Curve  $az = rr - 2ry + yy$ , and



consequently  $\dot{z} = \frac{2yy - 2ry}{a} = Ee$ ; and because the Sectors  $BEe$ ,  $BFR$  are similar, it is,

$$BE(r) : BF(y) :: Ee\left(\frac{2yy - 2ry}{a}\right) :$$

$$FR = x = \frac{2yy\dot{y} - 2ry\dot{y}}{ar} \text{ and the Fluxion thereof (supposing } x \text{ invariable) is } 4yy\dot{y} - 2a\dot{y}^2$$

$+ 2yy\ddot{y} - 2a\dot{y}\ddot{y} = 0$ . And consequently  $y\ddot{y} = \frac{a\dot{y}^2 - 2yy\ddot{y}}{y - a}$ . Now if we substitute these

Values of  $\dot{x}^2$  and  $y\ddot{y}$  in the general Theorem  $y\ddot{y} = \dot{x}^2 + \dot{y}^2$ , there will arise this Equation

$$\frac{ry^2 - 2yy\dot{y}^2}{y - a} = \frac{4y^4\dot{y}^2 - 8ry^3\dot{y}^2 + 4rryy\dot{y}^2 + rraa\dot{y}^2}{aarr}$$

which by Reduction, is  $4y^5 - 12ry^4 + 12rry^3$

$- 4r^3yy + 3rraa y - 2r^3aa = 0$ . And one of the Values of the Root  $y$  will be  $= BF$  requir'd.

#### Scholium 1.

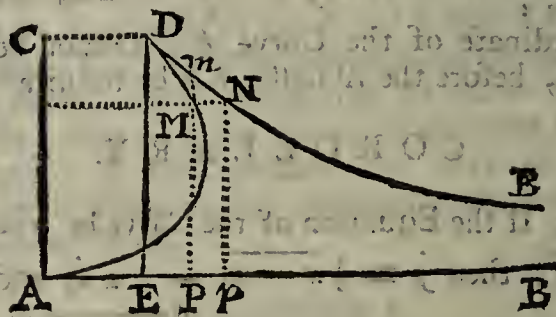
That the Curve  $AFK$ , which we may call a Parabolical Spiral, has a Point of contrary Flexion, may easily appear.

For the Circumference  $AED$  not differing sensibly near  $A$ , from the Tangent in  $A$ , its plain from the Nature of the Parabola, that the Curve must be concave towards that Tangent, and that afterwards the Curvature of the Circumference about its Centre becoming more and more sensible, the said Curve must be concave towards the said Centre  $B$ .

#### Scholium 2.

The Points of Retrogression of Curves may be found by help of first Fluxions in this manner,

192. If the Curve  $AMDB$  be such, that the Ordinates  $PMm$  intersect the same in two Points,  $M$  and  $m$ , then that Curve must have a Point of



Retrogression, viz. the Point  $D$ ; and to determine the same it must be observ'd, that if (the Abscissa)  $x$  be supposed invariable, then the Fluxion of the Ordinate (when it is greatest) which passes thro' the Point of Retrogression  $D$ , is equal to nothing; whence we may find the Value of  $AE$ , the Abscissa, corresponding to the same.

RETURN [in Law] hath two several Applications: The one is the Return of Writs by Sheriffs and Bayliffs, which is only a Certificate made to the Court, of that which he hath done touching the Execution of their Writ directed to him. And this among the Civilians is termed *Certificatorium*: Of Returns in this Signification speaks the Statute of *Westmin.* 2 Cap. 39. So is the Return of a Commission, a Certificate or Answer to the Court, of that which is done by the Commissioners, Sheriffs, or others, to whom such Writs, Commissions, Precepts or Mandates are directed. Also, certain Days in every Term are called *Return Days* or Days



Days in Bank ; and so *Hilary Term* hath four *Returns*, viz. *Octabis Hilarii*, *Quindena Hilarii*, *Crastino Purificationis* & *Octabis Purificationis*. *Easter Term* hath Five, viz. *Quindena Paschæ*, *Tres Paschæ*, *Mense Paschæ*, *Quinq. Paschæ* and *Crastino Ascensionis Domini*. *Trinity Term* hath Four, *Crastino Trinitatis*, *Octabis Trinitatis*, *Quindena Trinitatis*, *Tres Trinitatis*; and *Michaelmas Term* Six viz. *Tres Michaelis*, *Mense Michaelis*, *Crastino Animarum*, *Crastino Martini*, *Octabis Martini*, *Quindena Martini*. The other Application of this Word is in Case of *Replevin*; for if a Man Distrain Cattle for Rent, &c. and afterwards justify or avow his Act, so as it is found lawful, the Cattle before delivered unto him that was distrained, upon Security given to follow the Action, shall now be returned to him that distrained them.

**RETURNO habendo**, is a Writ that lies upon him that has avowed a Distress made of Cattle, and proved his Distress to be lawfully taken, for returning to him the Cattle distrained, which before were replevied by the Party distrained, upon Surety given to Prosecute the Action; or when the Plaint or Action is removed by *Recordari*; or *Accedas ad Curiam*, into the Court of *Common Pleas*, and he whose Cattle were distrained makes default, and doth not prosecute his Suit.

**RETURNS of a Trench** [in Fortification] are the Turnings and Windings which run from the Lines of the Trench, and are as near as can be, parallel to the Place attacked, to avoid being enfiladed.

**RETURNUM averiorum**, is a Writ Judicial, granted to one Impleaded for the taking the Cattle of another, and unjust detaining them *contra Vadium* & *Plegios*, and appearing upon Summons, and is dismissed without Day, because the Plaintiff makes Default; and it lies for the return of the Cattle to the Defendant, whereby he was Summoned, or which were taken for Security of his Appearance upon the Summons.

**RETURNUM irreplegiabile**, is a Writ Judicial, sent out of the *Common Pleas* to the Sheriff, for the final Restitution or return of Cattle to the Owner, unjustly taken by another, as *Damage-feasant*, and so found by the Jury before Justices of Assize in the Country, or otherwise by Default of Prosecution.

**REVE alias Gereve**, signifies with us the Bailiff of a Franchise or Manor, especially in the Western Parts of *England*: Hence *Shire-Reve* or *Sheriff*.

**REVEILLE**. For the Drum to beat the *Reveille* in an Army, is to give notice that 'tis Day-break, and that the Soldiers should rise, and the Centries forbear challenging.

**REVENUE**, signifies properly the Rent that accrues to every Man from his Lands and Possessions.

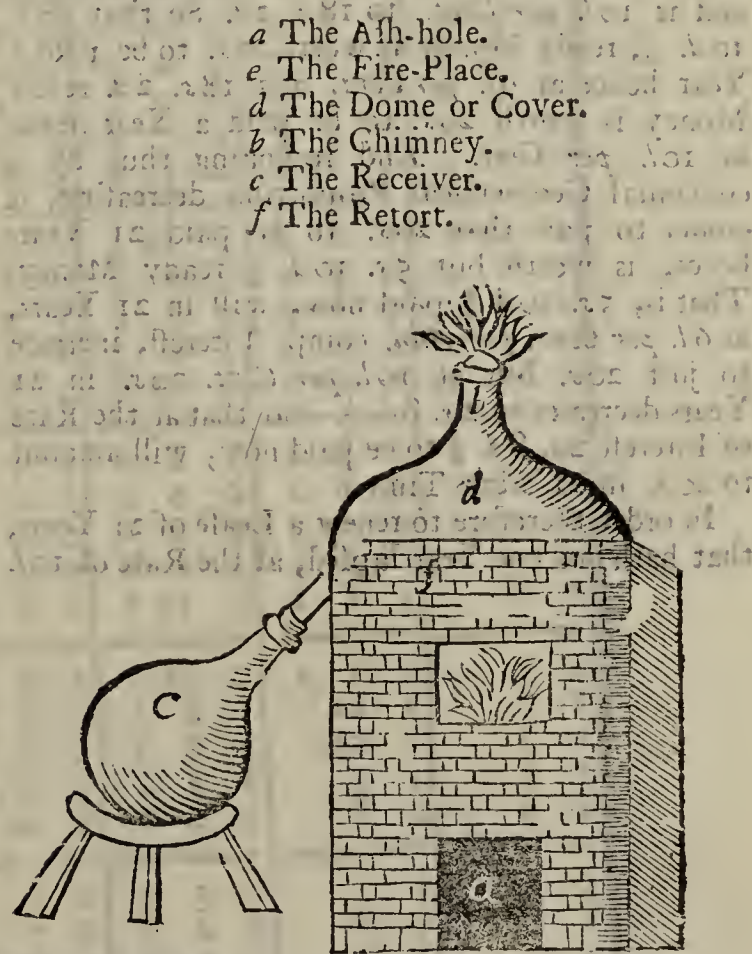
**REVERBERATE**: The Word signifies properly to strike, reflect, or beat back again. The Chymists say, *Make the Flame reverberate on the Coppel*. That is, Let either the Flame of the Wood be so blown with the Bellows, as that it may be beaten back down on the Metal; or else make the Sides of the Furnace so close all about, that the Flame striking against its Sides, may be beat back again down on the Matter to be melted. For which latter Purpose they have a particular Furnace called the

**REVERBERATORY Furnace**; which is a strong fix'd Furnace of two Bricks thickness, and must be large enough to hold a Retort, or more than one, for the Distillation of acid Spirits, and other Things. The Mortar or Lute for such a Fur-

nace is usually one part Potters Earth, as much Horse-dung, and two Parts of common Sand kneaded in Water. The Ash-hole must be about a Foot high, and the Door contrived, if possible, so as that the Air may come freely to it, to light the Fire the more easily, or to increase the Flame. The Fireplace need not be quite so high: At the top of it are two Iron Bars placed cross-wise, to set the Retort on; and then the Furnace is rais'd about a Foot higher, to cover or close the Retort: Then is there fitted to this a Dome or Cover with its Chimney, which is set on the top of the Dome on a little Hole, which when the Chimney is not used, hath a Stopple to it. This Dome may be made of the same Paste that portable Furnaces are usually made of; which see under *Furnaces*.

And one may make according to his Fancy, in Room, or Convenience, a Furnace of this Kind; and there is no need of keeping exactly to this Form, especially as to the Dome, which in a large Reverberatory may be made with Tiles or Bricks placed over the Retorts, and plaistered over with a Lute made of Ashes melted with common Water.

Here follows the Figure of Mr. Lemery's Reverberatory, which will serve to give an Idea of the former Description.



a The Ash-hole.

e The Fire-Place.

d The Dome or Cover.

b The Chimney.

c The Receiver.

f The Retort.

Such a Furnace as this, will also serve for many Uses, as well as Distilling *per Reverberium*; as to Distil with the *Refrigeratory*, in *Balneo*, &c. for the Copper Body may be placed on the Bars, and the Vessel holding the Water, Sand, Ashes, &c. as a little Practice will soon teach the Young Chymist.

**REVERSED Talon**. See *Talon*.

**REVERSING**, & [in *Musick*] the inverting  
**RENVERSING**, & the Order of the Parts, that is, the placing of the higher Parts or Treble, in the lower Part or Base.

**REVERSIONS**, or *Estates in Reversion*. In the little Book of Tables for Renewing and Purchasing College and Church-Leases, Printed at Cambridge 1700, and recommended by Sir *Isaac Newton*.

There is also shew'd the Construction and Use of the following Table of *Reversions*, which is cal.



calculated for several Rates of Interest. The Table shews the *Decrease* of 1*l.* yearly, according to the said several Rates; or which is the same thing, it shews you what one Pound due at the End of any Number of Years to come (not exceeding 40, which is the longest Term such Lands can be leased for) is now worth in Ready Money at 5, 6, 7, 8, 10 and 12 *per Cent. per Ann.*

And first, *What is 1*l.* due a Year hence, worth in Ready Money now?*

The Rule is this: Let 100*l.* with the Interest of a Year added to it, be the first Term in the Rule of Three; 100 The Second, and 1*l.* the Third. (For as 100*l.* with its Interest going on to the End of the Year, is to a bare 100*l.* then due: So must 1*l.* with its growing Interest, be to the Decrease of 1*l.* at the Years End. (Then at 6*l.* and 10*l. per Cent.* the Work will stand thus.

As 106. 100 :: 1. .94339 or 18*s.* 10*d.*  $\frac{1}{4}$ .  
110. 100 :: 1. .90909 or 18*s.* 2*d.*

From whence it appears that 1*l.* in a Years Time at 6*l. per Cent.* decreases to 18*s.* 10*d.*  $\frac{1}{4}$ . and at 10*l. per Cent.* to 18*s.* 2*d.* So that 18*s.* 10*d.*  $\frac{1}{4}$ , ready Money is worth 20*s.* to be paid a Year hence at 6*l. per Cent.* and 18*s.* 2*d.* ready Money is worth 20*s.* to be paid a Year hence at 10*l. per Cent.* And reckoning thus by a continual Geometrical Proportion decreasing, it comes to pass that 20*s.* to be paid 21 Years hence, is worth but 5*s.* 10*d.*  $\frac{1}{2}$  ready Money. That is, 5*s.* 10*d.*  $\frac{1}{2}$  paid now, will in 21 Years, at 6*l. per Cent. per Ann.* comp. Interest, increase to just 20*s.* But at 10*l. per Cent.* 20*s.* in 21 Years decreases to 2*s.* 8*d.*  $\frac{1}{2}$ . So that at the Rate of Interest 2*s.* 8*d.*  $\frac{1}{2}$  to be paid now, will amount to 20*s.* in 21 Years Time.

In order therefore to renew a Lease of 21 Years, that hath but one Year lapsed, at the Rate of 10*l.*

*per Cent.* I look into the Table of Reversions below, and under the Rate of Interest mentioned, and right against 21 Years in the common Angle of meeting, I have 2*s.* 8*d.*  $\frac{1}{2}$ , which is the Fine to be paid to renew one Year lapsed in the said Lease, and supposing the Rent to be 1*l. per Ann.* for it is 21 Years ere the Lease is compleated; in which Time the Fine of 2*s.* 8*d.*  $\frac{1}{2}$  will amount to 20*s.* and therefore by paying that Fine, the Lease may fairly be made up again.

Suppose again there be two Years lapsed in such a Lease, allowing the same Rate of Interest. Looking into the following Table of Reversions I find 20*s.* to be paid 20 Years hence, is now worth in ready Money 2*s.* 11*d.*  $\frac{1}{2}$ , add this Sum to the former of 2*s.* 8*d.*  $\frac{1}{2}$ , and their Sum which is 5*s.* 8*d.* is the Fine to be paid to make the Lease to 21 Years again, supposing the Rent to be 1*l.*

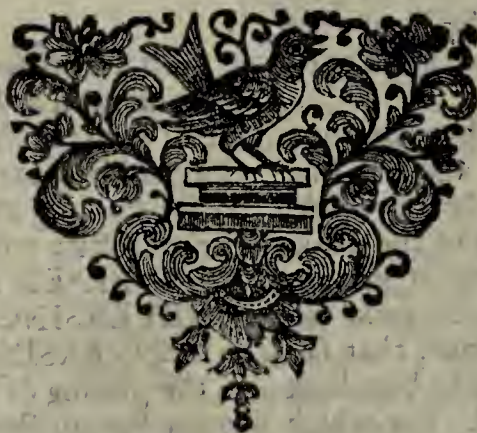
Suppose an Estate in Fee-Simple, whose real Value is 100*l.* but that it is *Mortgaged* or *Leased* out for 20 Years: What is the Reversion of it worth now, at 6*l. per Cent.* Interest?

By the Table of *Reversions* I find 1*l.* to be paid 20 Years hence, is worth but 6*s.* 2*d.*  $\frac{1}{4}$ , and multiplying that by 100, I find,

|  | <i>l.</i> | <i>s.</i> | <i>d.</i> |
|--|-----------|-----------|-----------|
| 100 times 6 <i>s.</i> is                             | 30        | 00        | 0         |
| 100 times 2 <i>d.</i> or 200 <i>d.</i> makes         |           | 16        | 8         |
| And 100 times $\frac{1}{4}$ , or 300 <i>q.</i> makes |           | 6         | 3         |
| Sum  | 31        | 2         | 11        |

Wherefore 31*l.* 2*s.* 11*d.* is the true present Value of 100*l.* to be paid 20 Years hence.

How to value the Reversion of any Lease or Annuity: See in the *Renewing of Leases.*





A Table of Reversions shewing what *l.* due any Number of Years hence under 41, is worth in ready Money, at 5, 6, 7, 8, 10, and 12 *l. per Cent.*

| Years. | 5 per Cent. | 6 per Cent. | 7 per Cent. | 8 per Cent. | 10 p. Cent. | 12 p. Cent. |
|--------|-------------|-------------|-------------|-------------|-------------|-------------|
|        | s. d. q.    | s. d. q.    | s. d. q.    | s. d. q.    | s. d. q.    | s. d. q.    |
| 1      | 19 0 2      | 18 10 1     | 18 8 0      | 18 6 0      | 18 2 0      | 17 10 1     |
| 2      | 18 1 2      | 17 9 1      | 17 5 2      | 17 1 3      | 16 6 1      | 15 11 1     |
| 3      | 17 3 1      | 16 9 2      | 16 3 3      | 15 10 1     | 15 0 0      | 14 3 0      |
| 4      | 16 5 1      | 15 10 0     | 15 3 0      | 14 8 1      | 13 8 0      | 12 8 2      |
| 5      | 15 8 0      | 14 11 1     | 14 3 1      | 13 7 1      | 12 5 0      | 11 4 0      |
| 6      | 14 11 0     | 14 1 0      | 13 4 0      | 12 7 0      | 11 3 2      | 10 1 3      |
| 7      | 14 2 2      | 13 3 2      | 12 5 1      | 11 8 0      | 10 3 0      | 9 0 3       |
| 8      | 13 6 1      | 12 6 2      | 11 7 2      | 10 9 2      | 9 4 0       | 8 1 0       |
| 9      | 12 10 2     | 11 10 0     | 10 10 2     | 10 0 0      | 8 5 3       | 7 2 2       |
| 10     | 12 3 1      | 11 2 0      | 10 2 0      | 9 3 0       | 7 8 2       | 6 5 0       |
| 11     | 11 8 0      | 10 6 1      | 9 6 0       | 8 6 3       | 7 0 0       | 5 9 0       |
| 12     | 11 1 2      | 9 11 1      | 8 10 2      | 7 11 1      | 6 4 2       | 5 1 2       |
| 13     | 10 7 1      | 9 4 2       | 8 3 2       | 7 4 0       | 5 9 2       | 4 7 0       |
| 14     | 10 1 0      | 8 10 0      | 7 9 0       | 6 9 2       | 5 3 0       | 4 1 0       |
| 15     | 9 7 2       | 8 4 0       | 7 3 0       | 6 3 2       | 4 9 1       | 3 7 3       |
| 16     | 9 2 0       | 7 10 2      | 6 9 1       | 5 10 0      | 4 4 1       | 3 3 0       |
| 17     | 8 8 2       | 7 5 0       | 6 4 0       | 5 4 3       | 3 11 1      | 2 11 0      |
| 18     | 8 4 0       | 7 0 0       | 5 11 0      | 5 0 0       | 3 7 0       | 2 7 0       |
| 19     | 7 11 0      | 6 7 0       | 5 6 1       | 4 7 1       | 3 3 0       | 2 4 1       |
| 20     | 7 6 1       | 6 2 3       | 5 2 0       | 4 3 2       | 2 11 2      | 2 1 0       |
| 21     | 7 2 0       | 5 10 2      | 4 10 0      | 3 11 3      | 2 8 2       | 1 10 0      |
| 22     | 6 10 0      | 5 6 2       | 4 6 0       | 3 8 0       | 2 5 2       | 1 8 0       |
| 23     | 6 6 0       | 5 3 0       | 4 2 2       | 3 4 3       | 2 2 3       | 1 5 2       |
| 24     | 6 2 1       | 4 11 1      | 3 11 1      | 3 1 3       | 2 0 1       | 1 3 3       |
| 25     | 5 10 3      | 4 8 0       | 3 8 1       | 2 11 0      | 1 10 0      | 1 2 0       |
| 26     | 5 7 1       | 4 4 3       | 3 5 1       | 2 8 1       | 1 8 0       | 1 0 2       |
| 27     | 5 4 1       | 4 1 3       | 3 2 2       | 2 6 0       | 1 6 1       | 11 0        |
| 28     | 5 1 0       | 3 10 3      | 3 0 0       | 2 3 3       | 1 4 2       | 10 0        |
| 29     | 4 10 1      | 3 8 1       | 2 9 2       | 2 1 3       | 1 3 0       | 9 0         |
| 30     | 4 7 2       | 3 6 1       | 2 7 2       | 1 11 3      | 1 1 3       | 8 0         |
| 31     | 4 5 1       | 3 3 1       | 2 5 1       | 1 10 0      | 1 1 0       | 7 0         |
| 32     | 4 2 1       | 3 0 2       | 2 3 2       | 1 8 1       | 11 1        | 6 1         |
| 33     | 4 0 0       | 2 10 1      | 2 1 2       | 1 6 3       | 10 1        | 5 2         |
| 34     | 3 9 2       | 2 8 3       | 2 0 0       | 1 5 1       | 9 1         | 5 1         |
| 35     | 3 7 2       | 2 6 2       | 1 10 2      | 1 4 0       | 8 2         | 4 2         |
| 36     | 3 5 1       | 2 5 1       | 1 9 0       | 1 3 0       | 7 3         | 4 0         |
| 37     | 3 3 1       | 2 3 2       | 1 7 2       | 1 2 0       | 7 0         | 3 1         |
| 38     | 3 1 2       | 2 2 0       | 1 6 2       | 1 1 0       | 6 1         | 3 0         |
| 39     | 2 11 3      | 2 0 0       | 1 5 0       | 1 0 0       | 5 3         | 3 0         |
| 40     | 2 10 0      | 1 11 0      | 1 4 0       | 0 11 0      | 5 1         | 2 2         |



REVERSION of a Series [in Algebra] is a Method to find a Number from its Logarithm, being given; or the Sine from its Ark: The Ordinate of an Ellipsis, from an Area given to be cut off from any Point in the Axis.

REVERSION [in Law] hath a double Acceptation, one is, *ius revertendi cum status possessionis defecerit*, and this is but an Interest in the Land, when the Possession shall fall.

Secondly, When the Possession and Estate which was parted with for a Time, ceaseth and is determined in the Persons of the Alienees, Assignees, Grantees, or their Heirs, or effectually returns to the Donor, his Heirs or Assigns whence it was derived.

The Difference between a *Reversion*, and a *Remainder*, is, that a *Remainder* is General, and may remain to any Man, but to him that granteth or conveyeth the Land, &c. for Term of Life only, or otherwise. A *Reversion* is to himself, from whom the Conveyance of the Land, &c. proceeded, and is commonly perpetual, as to his Heirs also. And yet sometimes *Reversion* is confounded with *Remainder*.

To REVERT, [in Law:] A Thing is said to revert, when it returns, or falls back, to its first Owner.

REVIEW. A Bill of Review in Chancery, is where a Cause hath been heard, and the Decree signed and enrolled; and some Error in Law appears upon the Decree made, which Bill cannot be exhibited, but by License of the Court.

REVIVE: When any mix'd Body is restored again to its Natural Form, and Condition from out of the Disguises it was in, by being mixed with some other Body, they say it is *Revived*.

Thus when Mercury is distilled from Cinnabar, they call it Mercury revived from Cinnabar; because the Mercury was made into Cinnabar only for safety and convenience of its being carried from Place to Place. See *Mercury*.

Bill of REVIVER, is where a Bill hath been exhibited in Chancery, against one who answers, and before the Cause is heard, or if heard, before the Decree enrolled, either Party dies: In this case a Bill of Reviver must be brought, that the former Proceedings may stand revived, and the Cause be finally determined.

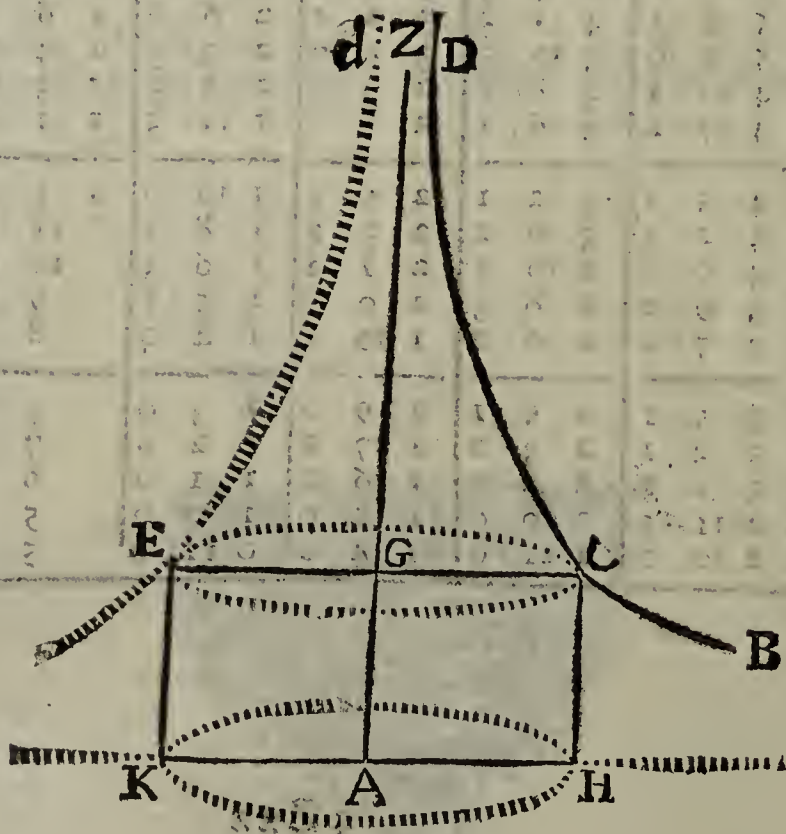
REVIVING [in Law] signifies a renewing of Rents and Actions after they be extinguished.

REVOLUTION [in Astronomy] is the Circulation of any Celestial Body, till it return to the same Point in which it was when it first began to move. But,

REVOLUTION, or as some call it, The *Restitution* of the *Anomaly*, is the Return of a Planet to any one Point of its Eccentrics, after it hath parted from it.

REVOLUTION [in Geometry] the Motion of any Figure quite round a fix'd Line (which is called therefore its Axis) is called the *Revolution* of that Figure; and the Figure so moving is said to *revolve*. Thus a Right-angled Triangle revolving round one of its Legs, as an Axis, generates by that Revolution a Cone. And to instance in a Case very wonderful; the Body called by *Torricellius*, *Hyperbolicum Acutum*, tho' it's self (as he demonstrates) be *Finite*, is yet formed by the *Revolution* of an *Infinite* Area: As in the Figure annexed.

Let *A* be the Centre of the Apollonian common Hyperbola *DCB*. *AZ* one of the Asymptotes, *GC* an Ordinate equal to the Abscissa *GA*. Compleat the Square *GH*. And supposing *Z* to be at an infinite Distance, imagine the Space *DCHAZ* to revolve about the Asymptote *ZA*, generating thereby the Body *DCHAKEd*, called the *Hyperbolicum Acutum*: I say the Conick Body *dEGCD* is finite, and exactly equal to the Cylinder *EKHC*: But yet the Asymptotick Space *GCD*, which its Revolution generates, is infinite.



For let a Unit, or 1. represent the Ordinate *GC* or *GA*. Then will the *Fluent* of the Space *ZGC* be  $\frac{x^0}{0} = \frac{1}{0} = \text{infinite}$ : And the *Fluent*

of the Body *dEGCD* is  $x^* = xyy =$  to the Cylinder *EKHC*.



**REVULSION** [in *Medicine*] the turning of a violent Flux of Humours from one Part of the Body to another, either neighbouring or opposite Part.

**REVULSORIA**, *V. S.* is whereby the Blood that gushes upon one part, is diverted a contrary way, by opening of a Vein in a remote and convenient place. This our Surgeons call frequently Bleeding for a *Revulsion*.

**RHABDOIDES** [*ῥαβδοειδης* of *ῥάβδος* a Rod, and *εἶδος* Form, Gr.] the second true Suture of the Skull, called the *Sagittal Sutures*.

**RHABDOLOGY** [*ῥαβδολογία* of *ῥάβδος* and *λόγος*, Gr.] a Method of performing the most difficult and operose Rules in Arithmetick, viz. Multiplication and Division by the two easiest viz. Addition and Subtraction, by the help of two little Rods or Lamina, on which are subscribed the simple Numbers, which are to be shifted according to Rules.

**RHACHITIS** [*ῥαχίτις*, Gr.] is, according to some, the Spinal Marrow; (which see in its proper place :) Also a Disease common amongst the *English*, which is an unequal Nourishment of the Body, accompanied with Looseness of Parts, Softness, Weakness, Faintness, Drowsiness, a great swelling Head, with Leanness below the Head; with Protuberances about the Joints, crookedness of Bones, straitness of the Breast, swelling of the *Abdomen*, stretching of the *Hypochondres*, a Cough, &c. The *English* call it the Rickets: But because the occasion of it often lies in the spinal Marrow, the Famous *Glysson* calls it appositely enough *Rhachitis*. *Blanchard*.

**RHAGADES** [*ῥαγίδες*, Gr.] the *Latins* say *Scissuræ*, *Fissuræ*, *Rimæ*, Chinks, Clefs, which as they happen in other parts of the Body, Hands, Feet, Lips, the Entrance of the Womb; so they may happen in the Fundament, in the Extremity of the Gut *Rectum*, and in the Sphincter, or Muscle which closes the Fundament. *Rhagades* in the Fundament are certain oblong little Ulcers, without Swelling, like those which are sometimes occasioned in the Hands by great Cold. Some are superficial, others deep: Some are not hard, nor callous, others are: Some are moist, and send forth Matter, others dry and cancrus. *Blanchard*.

**RHANDIX**, in the Division of the Country of *Wales*, before the Conquest; what they called a *Cantref*; contained an hundred Towns, under which were so many *Commots*: Each *Commot* had 12 *Manors* or *Circuits*, and 2 *Townships*: There were 4 *Townships* to every *Manor*; and every *Township* comprehended 4 *Gavels*: And every *Gavel* had 4 *Rhandixs*, and in every *Rhandix* were 4 Tenements. *Taylor's Hist. of Gavel Kind*, p. 69.

**RHEGMA** [*ῥήγμα*, Gr.] is a breaking forth or bursting of any part, as of a Bone, the inner Rind of the Belly, the Eye, &c.

**RHETORICK** [*ῥητορικη*, of *ῥέω* to speak,] the Art of speaking copiously on any Subject, with all the Advantages of Beauty and Force.

**RHEUM**, a thin ferous Humour, occasionally issuing out of the Glands of the Mouth and the Throat.

**RHEUMATISM** [*ῥευματισμός*, Gr.] is a wandering Pain in the Body, often accompanied with a small Fever, Swelling, Inflammation, &c. *Blanchard*.

**RHEXIS**, the same with *Rhegma*.

**RHINENCHYTES**, [of *ῥίη* the Nostril, and *ἐγχέω*, Gr. to pour in,] is a little Syringe to inject Medicines into the Nostrils.

**RHOMB Solid**, is two equal and right Cones joined together at their Bases.

**RHOMBOIDES**, [of *ῥόμβος* and *εἶδος*, Gr. Form,] so called from its Figure, is a Pair of Muscles of the *Scapula*, proceeding from the two lowermost Vertebres of the Neck, and from the four upper Spinal Processes of the Vertebres of the Back: By and by they descend obliquely, and being fleshy at the beginning and end, go as far as the Basis of the Shoulder-Blade, which they move backward and obliquely upward: It adheres strongly to its subjacent Muscle the *Serratus Superior Pecticus*.

**RHOMBOIDES**, a Figure in Geometry. See *Quadrilateral Figures*.

**RHOMBUS**: See *Quadrilateral Figures*.

**RHUMBS**: See *Rumbs*.

**RHYAS** [*ῥυας*, Gr.] a Disease of the Eyes, caused by a consuming or diminishing of the Caruncle, or small Piece of Flesh in the great Corner of the Eye, so that it can no longer contain its Liquor. *Blanchard*.

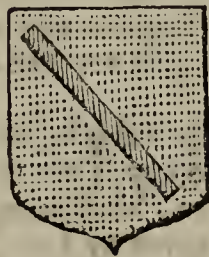
**RHYPTICA**, [of *ῥυπτέος*, Gr. filthy,] are scouring Medicines which cleanse away Filth. *Blanchard*.

**RHYTHMUS** [*ῥυθμός*, Gr.] is a certain Proportion of Pulses, Time, Life, Age, &c. *Blanchard*.

**RIAL**, a Piece of Gold, current for ten Shillings: In 1 *H. 6.* by Indenture of the Mint, a Pound-weight of Gold of the old Standard, was coined into 45 Rials going for ten Shillings a piece, or a proportionable Number of half Rials going at five Shillings a-piece: Or,

**RIALS Farthings**; which went at 2 *s.* 6 *d.* In 1 *H. 8.* The Golden Rial was ordered to go at 11 *s.* 3 *d.* In 2 *Eliz.* Golden Rials were coined at 15 *s.* a-piece, when a Pound-weight of old Standard Gold was to be coined into 48 Rials. In 3 *Jac. 1.* The *Rose Rials* of Gold were coined at 30 *s.* a-piece, and the *Spurr Rials* at 15 Shillings.

**RIBBING Nails**, are such as are used to fasten the Ribbing, or to keep the Ribs of a Ship in their Place.



**RIBBON**, a Term in Heraldry, signifying the eighth Part of a Bend; it is born a little cut off from the Out-lines of the Escutcheon, thus.

He beareth Or, a Ribbon Gules.

**RIBS of a Ship**, are the Timbers of the Put-tocks when the Planks are off; so called, because they are bending like the Ribs of a Carcase.

Those little long wooden Pieces also which belong to the Parrels of the Yards, and have Holes in them like the Comb under the Beak-head, are called the Ribs of the Parrels.

**RIDE**: A Ship is said to *ride*, when her Anchors hold her fast, so that she drives not away by the Force of the Wind or Tide; and a Ship is said to *ride* well, when she is built so that she doth not over-beat her self into a Head-Sea, as that the Waves over-rake her, (that is, over-wash her) from Stem to Stern. They say also a Ship

**RIDES a-crofs**, when she rides with her Main-yards and Fore-yards hoisted up to the Hounds; and both Yards and Arms topped alike. She is said to

**RIDE,**



**RIDE** a *Peek*, when one end of the Yard is peeked up, and the other hangs down: And this is also said of a Ship, when in Weighing she is brought directly over her Anchor. She is said to

**RIDE** *Athwart*, when her Side is to the Tide. And to

**RIDE** *betwixt Wind and Tide*, when the Wind hath equal Force over her one way, and the Tide another; but if the Wind hath more Power over her than the Tide, she is said to *Ride Wind Rode*. She is said to

**RIDE** *Hawse-ful*, when in a Stress of Weather she falls so deep into the Sea with her Head, that Water runs in at her *Hawses*. She is said to

**RIDE** a *Portoise*, when her Yards are struck upon the Deck, or when they are down a *Portlast*.

**RIDEAU** [in *Fortification*] is a Ditch, the Earth whereof is raised on its Side, or a small Elevation of Earth, extending it self in Length on a Plain, which serves to cover a Post, being also very convenient for those that would besiege a Place at a near Distance; and to secure the Workmen in their Approaches to the Fort of a Fortrefs.

**RIDERS** in a Ship, are great Timbers both in the Hold and also Aloft, which are bolted on to other Timbers to strengthen them, when 'tis discovered a Ship is too weakly built.

**RIDING Clerk**, one of the six Clerks in Chancery, who in his Turn, for one Year, keeps the Controllment-Books of all Grants that pass the Great Seal that Year. *Cowel*.

**RIENS** *Arreare*, is a kind of Plea used to an Action of Debt upon *Arrearages* of Account, whereby the Defendant does alledge, There is *nothing in Arrear*.

**RIENS** *passé par le fait*, is the Form of an Exception taken in some Cases to an Action.

**RIENS** *per Descend*, is a Form of Pleading when an Heir is sued for a Debt of his Ancestor, and he hath no Assets in his Hand, nor any Lands liable to be extended.

**RIGGING** of a Ship, is all her Ropes whatsoever belonging to her Masts or Yards, or any Part about her.

A Ship is well rigged, when all her Ropes are of their fit Size in Proportion to her Burden. She is said to be over-rigged when her Ropes are too big for her; which wrongs her much in her Sailing, and is apt to make her *Heel*.

**RIGHT** [in *Law*] signifies not only a Right for which a *Writ of Right* lies; but also any Title or Claim, either by Vertue of a Condition, Mortgage, or the like, for which no Action is given by Law, but only an Entry.

Thus is *Jus Proprietatis*, a Right of Propriety: *Jus Possessionis*, a Right of Possession: And *Jus Proprietatis & Possessionis*, a Right both of Property and Possession, and this was formerly called, *Jus duplicatum*: As if a Man be disseised of an Acre of Land, the Disseisee hath *Jus Proprietatis*, the Disseisor hath *Jus Possessionis*, and if the Disseisee release to the Disseisor, he hath *Jus Proprietatis & Possessionis*.

**RIGHT Angled**: A Figure is said to be Right Angled, when its Sides are at Right Angles, or stand perpendicularly one upon another: And this is sometimes in all Angles of the Figures, as in Squares and Rect-angles: Sometimes only in part, as in Right Angled Triangles.

**RIGHT Angled Triangle**: See *Triangle*.

**RIGHT Angles**: See *Angles*.

**RIGHT Ascension** of the Sun, or Star, is that Degree of the *Equinoctial*, accounted from the beginning of *Aries*, which riseth with it in a *Right Sphere*.

Or, it's that Degree and Minute of the *Equinoctial* (counted as before) which cometh to the Meridian, with the Sun or Stars, or with any Point of the Heavens. The Reason of which referring it to the Meridian, is because that is always at Right Angles to the *Equinoctial*; when the Horizon only is in a Right or Direct Sphere.

To find the Sun's or Star's *Right Ascension*, by the *Globe*.

Bring the Sun's or Star's Place to the Meridian, and the Number of Degrees intercepted between the beginning of *Aries*, and that Degree of the *Equinoctial* which comes to the Meridian, is the *Right Ascension*, if required in Time: Account every 15 Degrees to be an Hour, and every Degree to be 4 Minutes.

To find the Sun's *Right Ascension Trigonometrically*; having his greatest Declination and Distance from the next *Equinoctial* Point given; say,

As Radius is to the Co-sine of the Sun's greatest Declination :: So is the Tangent of his Distance from the next *Equinoctial* Point to the Tangent of the *Right Ascension*.

*Example.*

Let the Sun's Distance from the next *Equinoctial* Point be 30 Degrees 00 Minutes; his greatest Declination be 23 Degrees 30 Minutes.

Then to the Co-sine of 23° 30' ——— 9.962398  
Add the Tangent of 30° 00' ——— 9.761439

Sum less Radius is the Tang. of 27° 53' 19.723837

Which is the *Right Ascension* required.

The same may be also found, by having the present Declination, (suppose 11 Degrees 30 Minutes) and the greatest Declination, 23 Degrees 30 Minutes, given.

For, As the Tangent of the Sun's greatest Declination, is to the Tangent of his present Declination :: So is the Radius to the Sine of his *Right Ascension*.

The Operation stands thus:

To the Ar. co. of the Tan. of 23° 30' — 0.361698  
Add the Tangent of 11° 30' ——— 9.308463

Sum adding the Radius = S. 27° 53' — 19.670161

**RIGHT** or *Direct Sphere*, is that which has the Poles of the World in its Horizon, and the Equator in the Zenith: The Consequences of living under such a Position (as those who live directly under the Line are in) is that they have no Latitude nor Elevation of the Pole. They can see nearly both Poles of the World; all the Stars do Rise, Culminate, and Set with them. And the Sun always rises and descends at Right Angles to their Horizon,

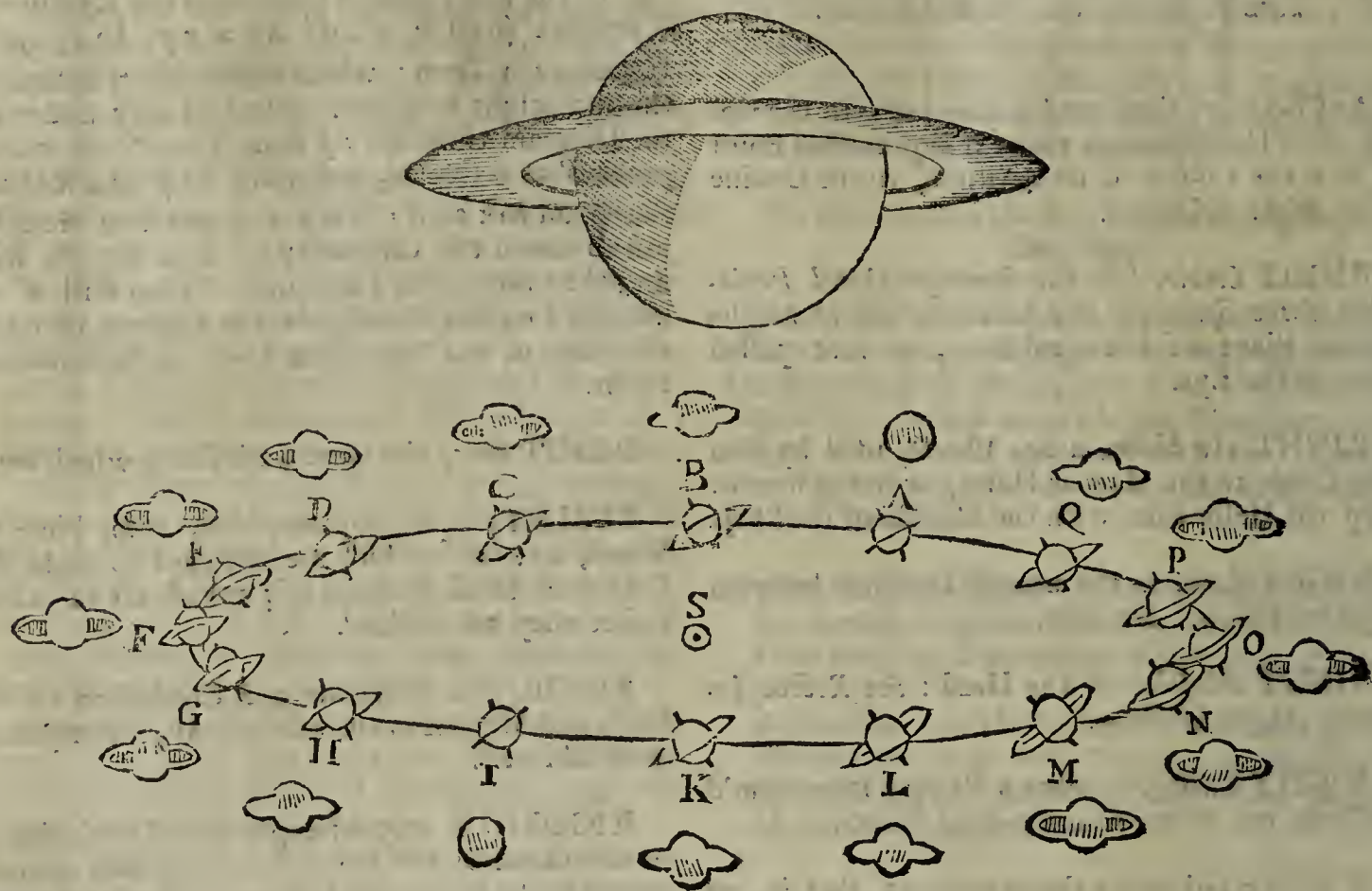






positions, in respect of the Sun at S. during the Planet's entire Revolution round the Sun. When the Planet is at A or I, the Ring is scarce visible, because the Sun's Rays running almost parallel to it,

can illuminate it but very sparingly. But when *Saturn* is at E. or N. then the Sun's Rays falling almost directly upon the Ring, do render it most of all conspicuous.



**RIOT** [in *Law*] signifies the forcible doing of an unlawful Thing, by three or more Persons assembled together for that Purpose.

**RIPENERS** [in *Medicine*] a Sort of Topical Remedies, call'd Digestives, *Maturantia*, &c.

**RISIBILITY**, [*Risibilitas*, L.] the Faculty of Laughing, which is generally suppos'd an Attribute peculiar to Man, as being the only Creature capable of judging of what is ridiculous. Authors are not agreed as to the peculiar Mechanism in Man, whereby Laughter is excited. It is commonly attributed to the Communication between the *Plexus Nervosus*, and the *Diaphragmatick Nerves*.

Some Philosophers assert, that the Degree of Judgment is always seen in that of Laughter; and that Fools have either too much, or too little.

**RISING of the Sun, or Star**, is their appearing above the Horizon.

The *Rising of the Sun* may be found by the Globe; thus.

First rectify the Globe, (which Word see;) then bring the Sun's Place to the East Part of the Horizon; and the Hour Index will shew the Time either before or after Six.

The Time of the Sun's *Rising* doubled, gives the Length of the Day.

The *Rising of any Star*, may be thus found by the Globe.

Rectify your Globe and Hour Index; bring the Star to the East, and the Index will shew the Time of the Star's Rising.

**RISING Timbers** in a Ship, are the Hooks placed on her Keel; and are so called, because as

these rise in Proportion, so her Rake and her Run rise on her flat Flo or by Degrees.

The **RISINGS** in a Ship, are those thick Planks which go fore and aft, on both Sides under the End of the Beams and Timbers of the Second Deck unto the third Deck, half Deck, and quarter Deck; and on them the Beams and Timbers of the Deck do bear at both ends by the Ship's side.

**RISUS Sardonius**, is a Contraction of each Jaw, or a convulsive kind of Grinning, caused by a Contraction of the Muscles on both sides of the Mouth. *Blanchard*.

**RIVERS** and *Springs*, whence they arise; see under the Word *Vapour*.

A **ROAD**, is in any place near the Land where the Ships may Ride at Anchor, and a Ship riding there is called a Roder.

**ROB.** See *Apochylisma*.

**ROBBINS** in a Ship, are those small Lines which make the Sail fast to the Yards, being reeved into Eylet-holes in the Sail under the Head-rope, for that purpose. The Word is, *Make fast the Robbins*: For at Sea they don't say, *tie*, but *make fast*.

**ROCKETS.** Of the several Defects of *Rockets*, how to avoid them; together with what ought to be observed in the right Construction of them.

The first and most remarkable Vice in *Rockets* is, When after being fir'd, and mounted to the height of two or three Perches, they break and disperse without performing their proper Effects.

The second, which is not much better than the first, is when they remain suspended upon the Nails, wasting slowly away, without moving off or rising at all.

The third is, when in their Ascent they form an Arch, or describing a Semi-circle return, down to the

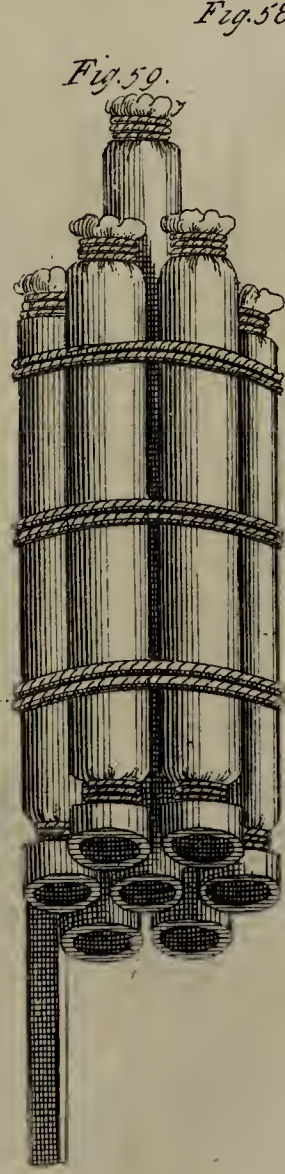
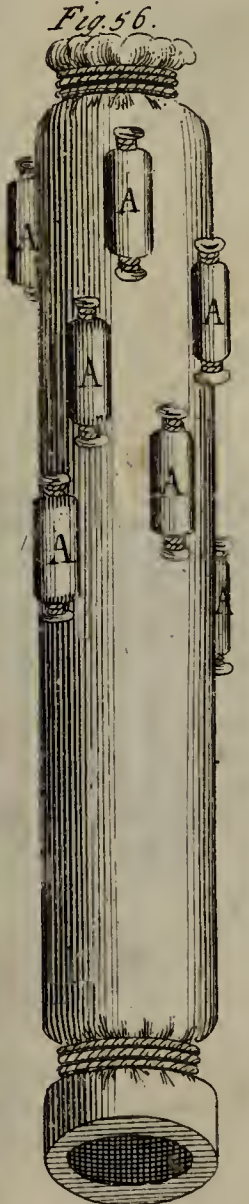
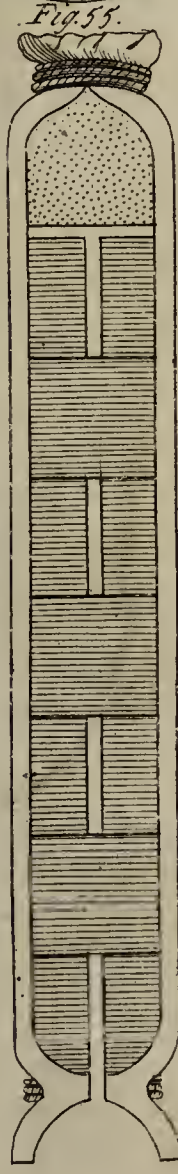
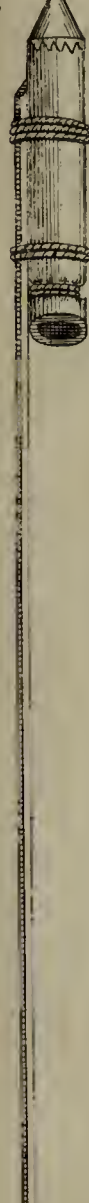
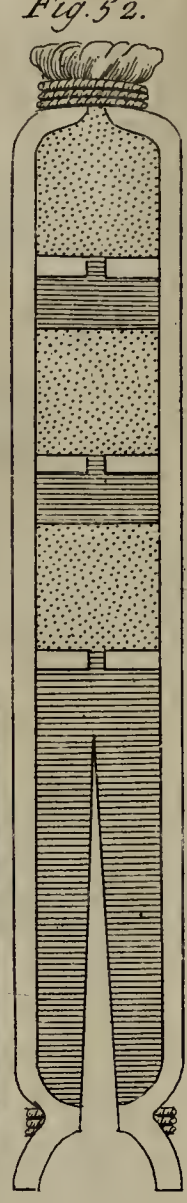
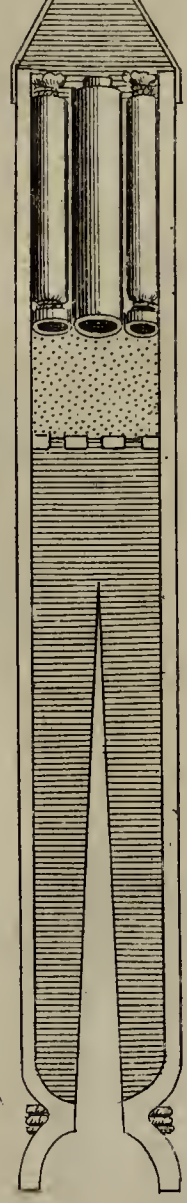
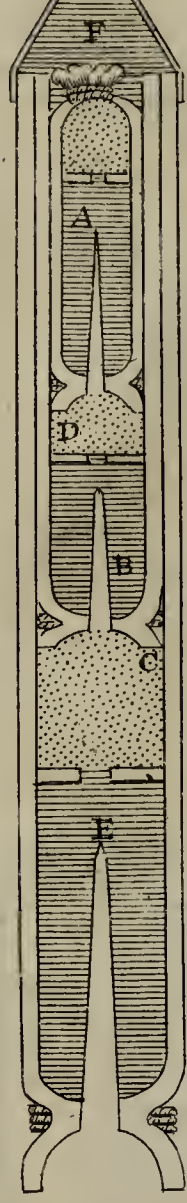
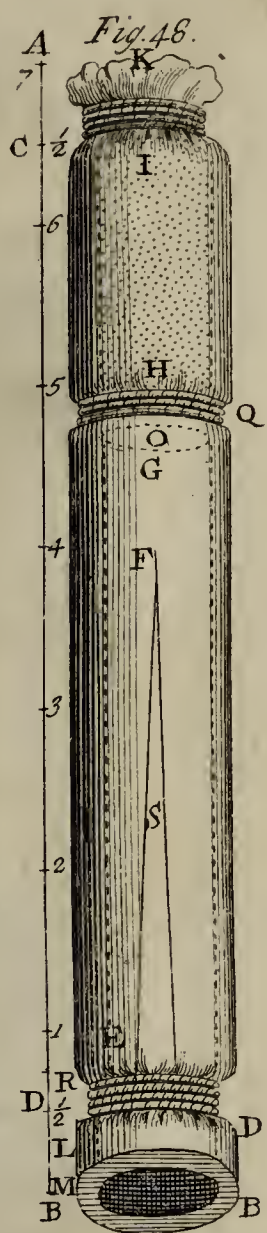


# ROCKETS, I.

Fig. 51.

Fig. 50.

Fig. 49. Place this at the Word Rocket









ROCKETS, II. Place this at the Word Rocket

Fig. 72.



Fig. 74.

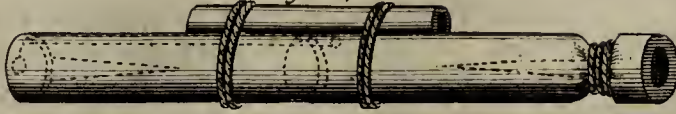


Fig. 75.

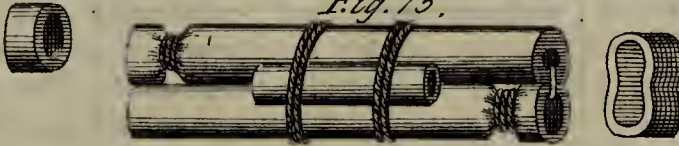


Fig. 75.



Fig. 78.

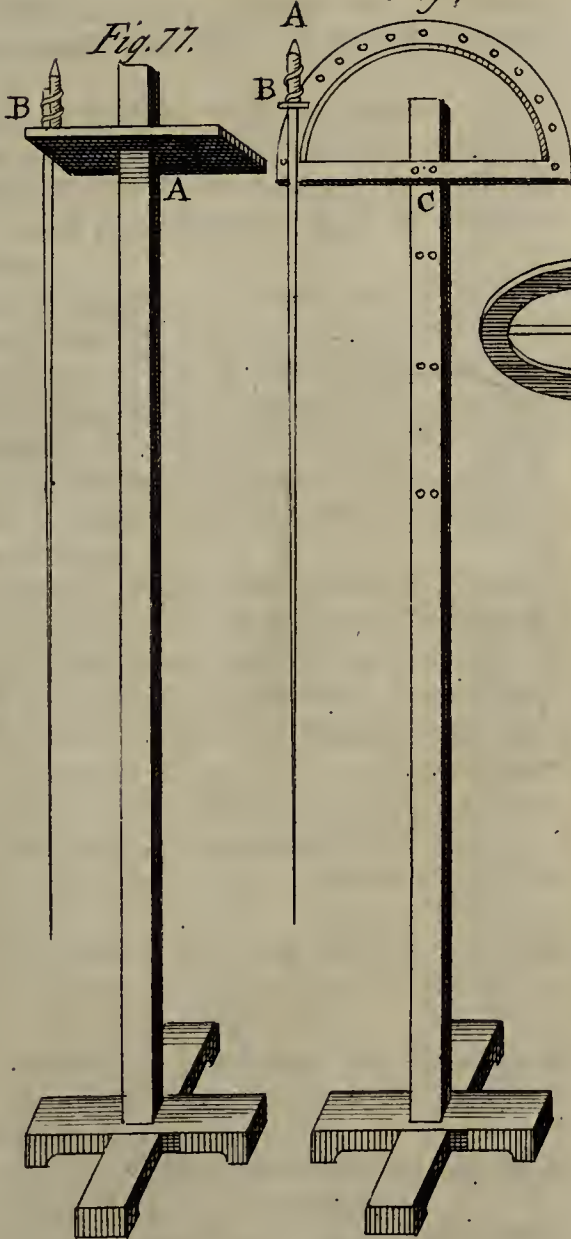


Fig. 79.

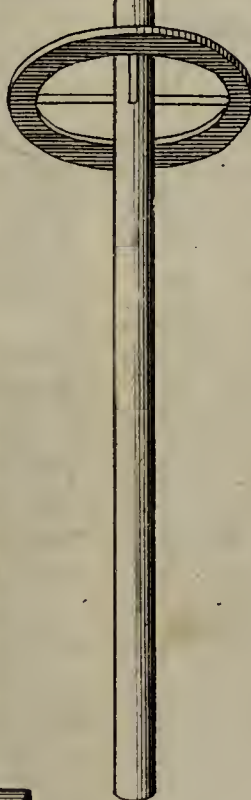


Fig. 70.

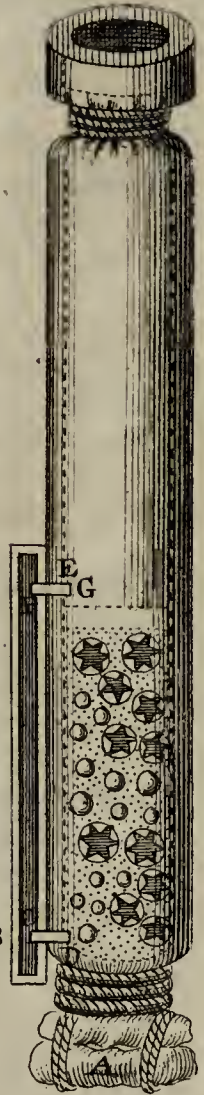


Fig. 71.

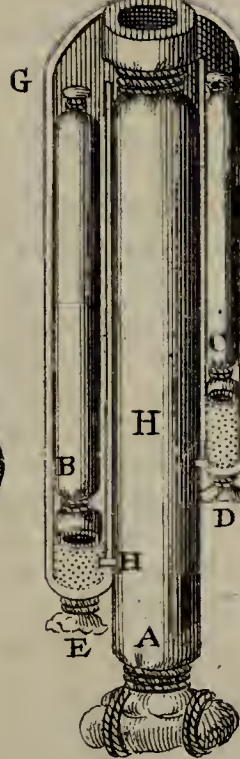
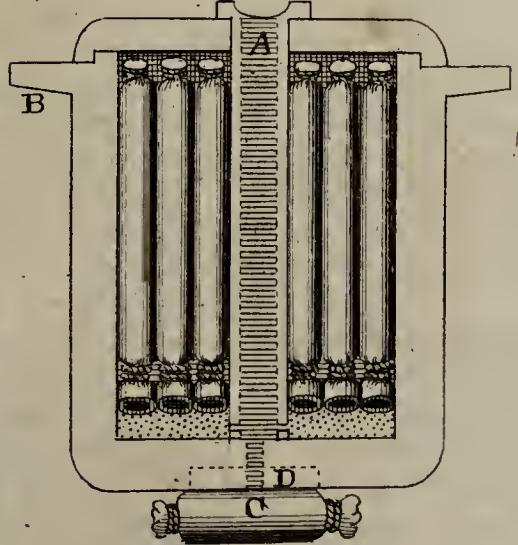
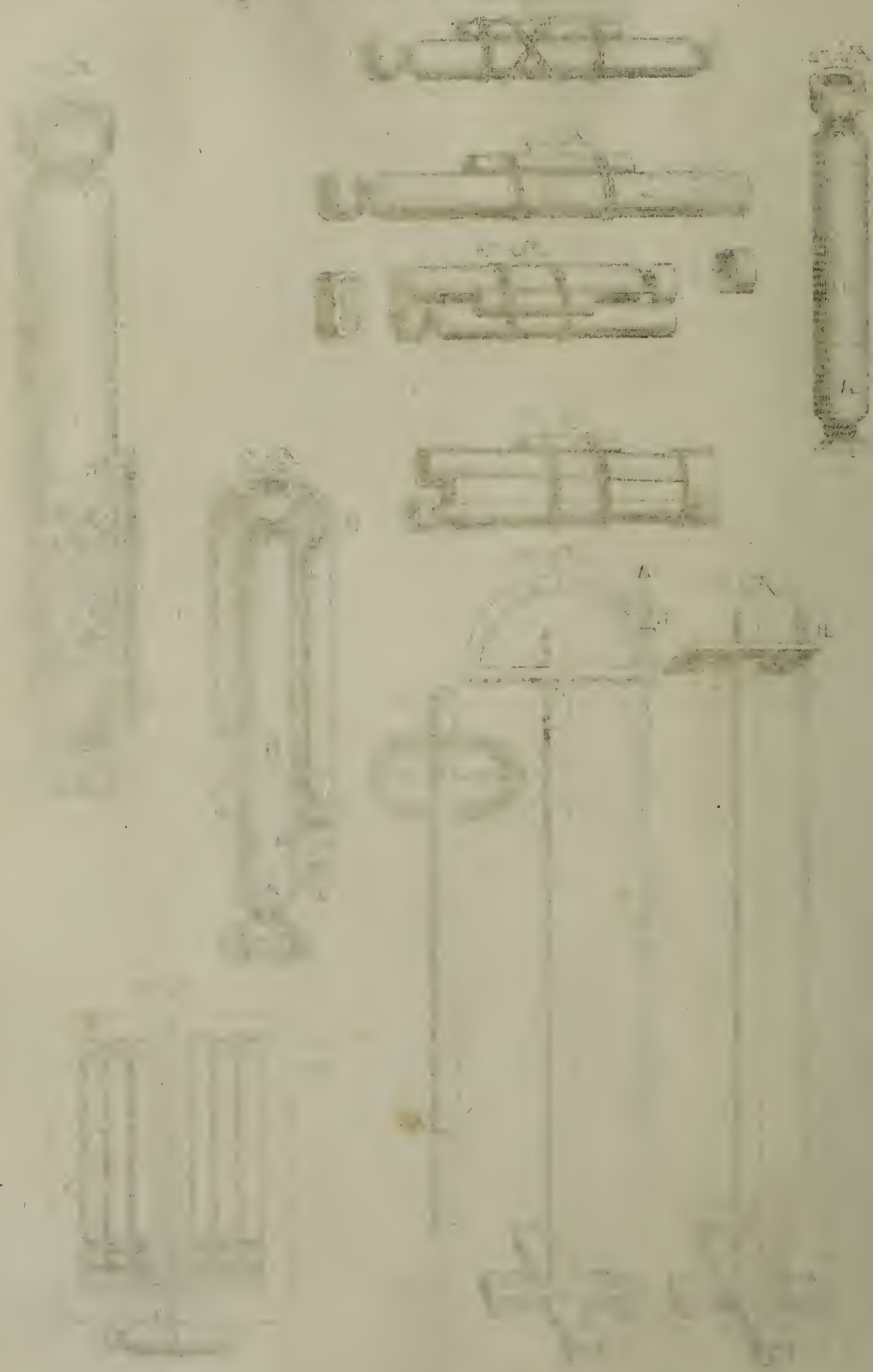


Fig. 83.





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the Ground before all their Composition is burnt out.

The fourth is, When they mount in a spiral Line, winding up into the Air, without observing an uniform, regular, and right Motion, as they ought.

The fifth is, When they move up heavily and lazily, as if they refus'd, or scorn'd, to take their Flight.

The sixth is, When the Cases hang empty upon the Nails, and the Composition rises and disperses in the Air.

There is still a greater Number of vexatious Accidents, which may frustrate the Hopes, Labour, and the Expence of the *Pyrobolist*; and which would be too tedious for me to enumerate. It will be sufficient, if you keep your Eye upon these, which are the most to be fear'd and provided against; and, in order to avoid and rectify them, please to observe the following Rules.

*Infallible Rules to construct Rockets, without any Defect.*

1. Your *Rockets* shall have their Height proportioned to their Orifices, or hollow Cylinders.

2. Whether your Cases be made of Paper or Wood, they shall be neither too thick, nor too thin.

3. They shall be made of Paper which is moderately dry, neatly rowl'd, and perfectly tight to the Rowler.

4. Their Necks shall be well and firmly choaked; so that neither the Knots of the Cord or Packthread, nor the Folds of the Choak, may dilate or give way; and therefore they shall be reinforced with Glew.

5. All the Ingredients that enter into the Composition, being exactly weighed in Proportion to the Orifice or Size of the Rocket you intend to make, shall be first powdered and passed through a Sieve seperately, then weighing them again they must be well incorporated together in one Mass, and powdered a second time and passed through a fine Sieve, as before.

6. The *Salt-petre* and *Sulphur* must be purified and powdered as fine as possible; the Coal must be well burnt, free from Moisture, and made of some light Wood, such as Lime-Tree, Hazle, and Branches of Willow; and on the contrary be caution'd not to make it of Beech, Oak, Maple, or Service-Tree, because they are naturally impregnated with a great deal of gross earthy Matter.

7. Your Composition must be prepar'd just before you want it.

8. It must be neither too moist nor too dry, but sprinkl'd over with a little oily Moisture, or Brandy.

9. When you drive your *Rockets*, be always mindful to put equal Quantities of Composition into your Cases at a time.

10. The Strokes of your Mallet shou'd fall in a perpendicular Direction upon the Driver.

11. Your *Rockets* must be driven with Mallets of proportionable Weight to their Size, with an uniform Succession, and an equal number of Strokes, every time you pour any Composition into your Cases.

12. In Paper Cases you must cover your Composition with wooden Cases, with an hollow convex or curve Surface; but for wooden Cases their Convexity shall be plain, that they may be the more firmly secur'd in the *Rocket*.

13. Your *Rockets* must be bored with a suitable Borer, or Taper-bit, so that their hollow Cones may be neither too wide nor too narrow, too long nor too short.

14. The cavity or hollow Cone must be as upright and perpendicular as possible, and exactly in the middle of the Composition, so as not to lean to the one side or the other.

15. You must not bore your *Rockets* till just before you use them, and when they are bored they shou'd be tenderly handled with the ends of your Fingers only, for fear of disordering their Form.

16. Their Sticks or Rods shall be nicely proportioned to them, both as to Length and Weight. They shall neither be bent nor crooked, uneven nor knotty; but as strait and smooth as possible, and if need be they may be planed.

17. Your *Rockets* being fill'd and compleated, take Care how you put them into too dry or too damp a Place; for both the one and the other may spoil them, therefore choose some temperate Place.

18. When you would fire them they must be suspended upon Nails perpendicular to the Horizon.

19. You must not oblige them to move off with Burthens disproportionate to their Strength; and tho' you are so exact as to load them with suitable Weights, the whole must be adjusted with regard to Form, so as that it shall with the most ease cleave the Air and rise with the least Opposition; so that their Burthens may in no respect retard their Rising, which is a Motion the most unnatural and difficult to any Body. And this you are to observe the more nicely, the larger your *Rockets* are, which must retain in general (as much as possible) a Pyramidical or conick Figure, as being the best adapted of any shape whatsoever to pierce the Air, and to meet with the least resistance from that Element. Tho' I must observe, that a spherical Form is the most convenient for a Body which is to turn, rowl, and vault in the Air, because of the equality of its Surface.

20. You must avoid, as much as possible, all Rainy, Damps, Misty and Foggy Nights, as also those which are Tempestuous or Squally.

21. The different Effects produced by several *Rockets*, fill'd with the same Composition, must not be attributed to any other Cause than their not having been treated with equal Diligence in every respect, whether in the Driving or Boring of them, and in many other Articles which ought to be strictly observed; or else to their having been laid up in Places of different Degrees of Dampness, and having thereupon contracted different degrees of Moisture, their Flight and Combustion will be various.

22. If you would have them make an appearance in the Air like Fire, Rain, or like a Cloud of fiery Sparks, or like long and broad Rays darting downwards, you must mix your Composition with a little Glass coarsely powdered, of filings of Iron, or Saw-dust of Wood. You may also contrive so as to have the Fires issuing from your *Rockets* of divers Colours: as for Example, If you mix a certain Quantity of *Campfire* in your Composition, it will yield a white, pale, or milky coloured Fire. If you mix a little *Greek Pitch* in it, it will produce a reddish Copper-Colour Flame. If you mix *Sulphur* you will have a blue Fire. If *Sal Armoniack*, it will be greenish. If crude *Antimony*, the Flame will be of a sad yellow,



yellow, or of Box-colour. If the scrapings of Ivory, it will be of a bright Silver-colour, inclining a little to the livid or Lead-colour. If the scrapings of yellow *Amber*, it will appear the same, but inclining to the Citronish. In short, If you mix your Composition with common *Pitch*, your *Rockets* will cast forth an obscure gloomy Fire, or rather a black thick Smoke, which will darken all the Air. The *Sieur de la Porte*, (sometimes called *Baptista Porte*) tells us, in his *Natural Magick*, Book 7. Chap. 7. that the Loadstone being buried under burning Coals, commonly emits a Flame that is of a bluish, sulphurine, or Iron-colour. Whoever doubts of this, may make the Experiment by scraping a little of it into your Composition, and see whether it be as he says, or not; but however let him do it with Moderation, and sparingly, for fear lest a disproportionate Quantity should deceive him, in some degree or other. But I think I have said enough concerning *Rockets*; and I fear I begin to grow tiresome to the Reader, and that I shall strain his Sight too much if I keep him any longer looking up to the Sky. And indeed I apprehend that I have left nothing unsaid that may be of use to the diligent and expert *Pyrobolist*, and that I have fully warn'd him, as to what he ought to embrace or fly, what he is to follow or avoid. But before I conclude, I must observe, that it's impossible to meet with any Artist so perfect, but that he may err sometimes in some trivial Point, where such a multiplicity of Circumstances must be kept in mind; therefore we ought not to pass any Judgment upon a *Pyrobolist*, or infer any thing to his Advantage or Disadvantage, from his good or bad Success in the construction of *Rockets*. It would be endless to enumerate how many different Accidents may happen in carrying on such ticklish Works (tho' at first sight they appear no other than childish Amusements) or even to tell of what Consequence an almost incomprehensible number of Particulars may be, which *Argus* himself, with all the Eyes bestow'd on him by fabulous Antiquity (in allusion to his great Segacity and Watchfulness) would not be able to keep continual sight of, much less falling into some little Mistakes, and consequently would be far from providing against them all in general. Therefore all that can be done in this Case, is to take the Advice of good Matters, and to consult able *Pyrotechnicians*, who often lay their Hands to the Work.

Now the whole Excellence, or universal Knowledge of *Pyrotecherics* doth not consist in the Construction of *Rockets*, which is but the least Part of that great and noble Art; and accordingly we find that they are never employed but upon tumultuous Rejoicings on the score of Victories obtain'd, Towns surrender'd, or Sieges rais'd, or sometimes at the celebration of Marriages, or at solemn Festivals to divert the Guests; and, in short, at publick Bonfires exhibited to please the People only.

*Of Sky-Rockets that mount up with their Sticks.*

#### Sort 1.

The *Rocket* represented in Figure 48, which we have already supposed to be of 1 lb. has its Height *AB* 7 Diameters in like manner as is the Mould: But from this Height we must first Retrench half a Diameter for the Neck *LM* as the Line *BD* shews upon *AB*. Moreover for the Binding and

Folds of the Choak to  $E \frac{1}{4}$  Diameter must be cut off or allowed; and, in short, for the binding of the Head you again take from this Height  $\frac{1}{2}$  a Diameter, as may be seen in *KI* and *AC*, therefore the Height of the Composition and Report will be  $5 \frac{1}{4}$  Diameters, as you see in *EI* or *CR*. Now divide this Height into three equal Parts in the Points *S* and *G*, and fill it with a Composition suitable to its Size (as we have already cautioned you) from *E* to *G*, that is, to  $\frac{2}{3}$  of the height *EI*. This done, cover it with a little Cap of Paper or Pasteboard, *G*; or what will be much better for Great *Rockets*, a round hallowed Wooden Cap, such as you see represented in Fig. 43. which shall be firmly glued to the Sides of the *Rocket*. If your Case be made of Paper or Pasteboard you shall with a strong Cord choak or force it into the hollow in the Curve Surface of this wooden Cap, which Cord may remain to confine it in, as you see in *Q*. But if the *Rocket* Case be made of Wood, this Cap needs not have its convex Surface hollowed, but let it be uniform and plain; allowing its Thickness to be  $\frac{1}{3}$  of the Diameter of the *Rocket*. You shall fasten it to the inside of the Case with little Nails or wooden Pegs, which shall be driven into it from the outside and then well secured with Glue. You must be particularly careful in doing this; for I have often seen the Cases of great *Rockets* remain empty upon the Nails without rising at all, and the Composition, for want of being powerfully confined at top, slip up through the Case and consume in the Air without performing the Effect expected: However, small *Rockets* which are choaked at top are not liable to this Accident. There must be a Hole made through this Cap of  $\frac{1}{4}$  of the Diameter of the *Rocket*, several of which may be made, if upon that Cap you would put running *Rockets* or (as they are usually called in English) *Squibs*, and other little Decorations, which are used in artificial Fire-works. Over this Cap you shall fill the remainder of the Case with good Corn-Powder, which shall be pressed down so gently as no way to have its Corn defaced or broken that they may be able to retain their vigour. In short, It must be bound up close at top, and then bored from *E* to *F*, to the height of  $\frac{2}{3}$  of the length of the *Rocket*, minus a Diameter of its hollow Cylinder, viz. *NO*; which being set off downwards from *G* towards *E* gives *EF*, which is the height it ought to be bored.

#### Sort 2.

Take a *Rocket*-Case whose hollow Cylinder is equal in Diameter to a leaden Bullet of 10 Loths, or 5 Ounces, let its height be 4 and  $\frac{1}{4}$  Diameter, and filled with a suitable Composition to 3 Diameters, and the bored to the depth of two of the same. Cover the Composition with a wooden or pasteboard Cap, having a Hole through it of  $\frac{1}{4}$  of the abovementioned Diameter, then let the top be closed up with a strong Packthread. The fashion of this *Rocket* may be seen in Fig. 49. where it is distinguished by the Letter *A*. This done, take another Case, the Diameter of whose Orifice is equal to a leaden Bullet of 24 Loths, or 12 Ounces, and let it be 5 Diameters of its Mould; this must be filled with a proper Composition to the height of  $1 \frac{2}{3}$  Diameter of its Orifice, and artfully bored to  $1 \frac{2}{3}$  of the same Diameter, so that there may remain  $\frac{1}{3}$  of a Diameter of solid Head; cover this with a Cap, as before, and upon that Corn-Powder, to the height of  $\frac{2}{3}$  of a Diameter. In short, over all



all this you must put the *Rocket* you had before prepar'd, which shall be firmly pasted to the inside of this. You will see the Construction of this last *Rocket* with the first in it, in the same *Figure* distinguished by the Letter *B*. To conclude, Take the Case of a third *Rocket* of 2 lb. whose height shall be to its Diameter as before prescrib'd, and fill it with a suitable Composition to the height of  $2\frac{1}{4}$  Diameter: You must cover this with a wooden Cap, whose thickness and the Diameter of the Hole through the middle of it, shall be half the Diameter of the Mould; and over that a Report of Corn-Powder to the height of one Diameter of the *Rocket*: This done, take the *Rocket B*, with the first *Rocket A* in it, and putting it into the hollow of this third, glew or paste them neatly together, and cover them all three with the conic Head *F*, made either of Wood or Paper. You have the whole Order of this *Rocket* in the same *Figure*, distinguished by the Letter *E*.

Observe here first, that the Necks of the two first *Rockets* do not exceed  $\frac{1}{4}$  Diameter; secondly, that you may take three larger or three smaller *Rockets*, and dispose of them after this manner: But you must take care, that your two lesser ones be shorten'd in such a manner, that the third may not lose any of its height; and in like manner, on the contrary, that they be not so high as never so little to exceed the third that contains them; and let them always be so proportion'd, that the first exactly fills up the second, and the second, with the first in it, exactly fills up the third. If it happens that the Necks of your *Rockets* do not nicely observe the proportion I have laid down, it will be no great matter, provided that their Diameters be as they ought to be: And in this case, the third *Rocket* must be driven with a slower Composition than its Size requires. Thus the two first will, by the third, be carried up into the Air, where they perform their Parts, flying from one side to the other in oblique Directions; for they cannot ascend perpendicularly for want of Sticks, or a Counterpoise; but we shall touch upon that at the End of this Subject.

## Sort 3.

Take a great *Rocket*, viz. of 2, 6, 8, or if you will of 10 or 20 lb. and fill it with a Composition suitable to its size, and bore it as usual; according to the Method directed in the first sort of *Rockets*; and after having covered it with a Cap, with several Holes pierced through it, as you may see in *A*, you shall salt it over with Meal Powder, mixed with an equal Portion of that in Corns. Then fill up the remaining Cavity of the *Rocket* with small running *Rockets*, or (as we call them in *English*) Squibs, and leave a space in the middle of them for a Wooden Case or Tube which you see represented in *Fig. 54* and which you shall prepare after the following manner. Take a hollow'd Cylinder or Tube of Wood equal in height to the space left of the *Rocket*; or it may be continued up to the inner Vertex of the Cone that crowns your *Rocket*; let the thickness of the Wood *ab*, be  $\frac{1}{4}$  of the Diameter *ac*; and let the bottom *fg*, be  $\frac{2}{3}$  of the same Diameter to which may be fastened a leaden Bullet by way of Counterpoise. This Tube or Case shall be filled thus; first pour in Corn-Powder to the height of  $\frac{1}{2}$  a Diameter and upon that a light Ball; over this Ball put slow Composition, upon this Corn-Powder again in the

same proportion as before, and upon that another light Ball, then slow Composition; and in this order you must proceed till your Case or Tube is filled up. We shall treat of slow Compositions hereafter. The whole being disposed after this manner, and the Tube filled as we have directed, well re-inforced with good Iron Wire, or strong glued Packthread for fear the Powder should split it, it shall be fixed in the middle of the Squibs with its Mouth downwards upon the Meal and Corn-Powder abovementioned. The whole being thus compleated, shall be closed at top, with a wooden or Paper Head, according as the *Rocket* Case is made of either the one or the other of them. You have a full and particular Representation of this in *Fig. 50*.

## Sort 4.

This kind of *Sky-Rockets* differs but little from the foregoing except that instead of small *Rockets* or Squibs in the empty place above the Composition, you shall put either Sparks or Stars (which we shall teach you to make afterwards) interspersed with Meal and Corn-Powder: As for any thing else relating to it, you are to proceed in the same manner we did with the first. See the Representation of this in *Fig. 51*.

## Sort 5.

You shall take a *Rocket* of any size you will, and fill it with a proper Composition to  $2\frac{7}{8}$  Diameters of its Orifice or hollow Cylinder; and cover it with a wooden Cap, whose thickness is  $\frac{1}{8}$  of the same Diameter; and over that Corn-Powder to the height of  $\frac{6}{8}$  of a Diameter; and upon that, Composition to  $\frac{2}{3}$  of a Diameter: This must be covered with a Cap, and that again with Corn-Powder; as before; and upon that Composition as before, and so on till the *Rocket* is quite filled. This done it shall be tied close and firm at top, and bored to the depth of  $2\frac{3}{4}$  Diameters. *Fig. 52*. Shews you the whole order of this.

## Sort 6.

You shall first take a *Rocket*, and fill it according to the common Rule and Order, and bore it as we did the *Rocket* of the first Sort. This done, prepare certain Boxes or Cases of dry light Wood, the same as you see represented in *Fig. B*, under *Fig. 53*. or else firm Paper Cases like those of *Rockets* choaked close at bottom. Then with hot glue stick as many as you please of them, to the exterior Surface of the *Rocket* as you see in *C*, minding to place them in a spiral Direction, and tie them fast with good Packthread as you see in Letter *D*. Into each of these Boxes put a running *Rocket*, filled with Meal-Powder, and opened at the Choak through which and the Boxes the Fire may be conveyed from the greater *Rocket*. The great *Rocket* might serve for a Petard or Cracker filled with Corn-Powder, but instead of that you may use Iron Crackers, whose upper part shall be filled with fine powder and the lower part with *Rocket* Composition. The Letter *A* shews you one of the abovementioned Boxes, with the running *Rocket* in it to render the thing more easy to to your apprehension.

## Sort 7.

Fill a *Rocket* with a reasonable Composition, to the height of 2 Diameters of its Orifice, and



bore the same Composition to the depth of one Diameter and to the breadth of  $\frac{1}{8}$  Diameter cover this boring with a Piece of Paper only, to prevent its being filled up whilst you drive the rest of the *Rocket*; this Order you are to observe till your *Rocket* is quite filled (namely) by always putting in 2 Diameters of Composition and boring one. See *Fig. 55*.

*Sort 8.*

You must here observe the several Circumstances relating to the 1st, 4th, and 6th Sorts, as well in filling this *Rocket*, as in boring it. Suppose then that you have a *Rocket* prepared, as it ought to be: You shall stick round the out-side of it, as many Paper Crackers as you shall think fit, (such as you see distinguish'd by *A*.) and at such distances as you shall think proper. Then prime both them and the *Rocket* with Meal-Powder. *Fig. 56* plainly illustrates this.

*Sort 9.*

This ninth sort of *Rocket* shall be prepared after the following order. You shall first fill the *Rocket* with a suitable Composition to the height of  $2\frac{5}{8}$  Diameters, which shall be covered with a wooden Cap having an hole through the middle of it: And over the Cap you shall put a layer of Corn-Powder to the height of  $\frac{1}{2}$  of the Diameter of its Orifice; upon which shall be a Layer of Composition to the height of  $\frac{2}{3}$  of the height of the same Diameter. Then taking a strong Cord, choak the *Rocket* close above the Composition, leaving only a small Hole of Communication in the middle of it; this done you shall put in Composition afresh to the height of  $\frac{2}{3}$ , and upon the said Composition Corn-Powder to the height of  $\frac{1}{2}$ . In short, upon this Powder you shall put Composition to the same height as before, and choak it again a second time: In this Order you shall proceed till the *Rocket* is filled up. This will appear obvious to you in *Fig. 57*.

*Sort 10.*

This *Rocket* has nothing particular in it, to make it very different from the rest; for, first, it is fill'd and bor'd after the same manner with those of the 1st, 4th and 6th Sorts: There is only one addition to it of a Report, and upon that a longish hollow piece of Wood in a spherical Form, fill'd with an aquatic Composition, (by aquatic I mean such Compositions as are contrived to turn upon, or in, Water) or any other strong Mixture. You must fire this *Rocket* at the Head, before you fire it at the Orifice of the Choak, because the upper Composition has no Communication with the lower Part of the *Rocket*. Being then moved off and taken its flight into the Air, you will see two sorts of Fire (namely) that of the *Rocket's* darting its Rage downwards, and the other issuing from the Head and spreading abroad in the Air like a great Fire-Rain. This is clearly explain'd in *Fig. 58*.

*Sort 11.*

Take seven small *Rockets* of 2, 3, 4, or more Ounces, fill'd with a common Composition, and bored as usual, bind them up together in a round tight Bundle, and wrap them about with strong Paper, or Pastboard, and head them with a large Cone of the same, as you see in *A*. You must not

forget to stick them in such a manner, that the upper end of the Stick may come under the great Paper-Case that encompasses the *Rockets*. *Fig. 59* will fully instruct you as to this.

Observe here, that the several sorts of *Rockets*, I have been now treating of, require to have Sticks fastn'd to them as a Counterpoize, and to assist them in their right Ascent. They are usually made of light dry Wood, such as Pine, Fir, or Lime-Tree. Their length must be to that of the *Rocket* in a Septuple, or at most an Octuple proportion; that is, they are commonly seven or eight times the length of the *Rocket*; they ought to be of a tolerable thickness at the end to which the *Rocket* is fixed, and from thence down to the lower end go gradually tapering to a Point. The necessity there is for them is not so much on the Score of their Figure, as on Account of the extream Equality as to Weight, or the nice *Equilibrium* which must be observed in fitting them to the several Weights of *Rockets*. Now you will find it no great Difficulty to adjust them exactly, if you put the Stick at two Fingers breadth from the Neck of the *Rocket* upon the edge of a Knife, or upon your Finger, and if in that Situation both ends are in *Equilibrio*, you are right; that is, the end to which the *Rocket* is fastened the other must be exactly parallel to the Horizon; without inclining or wavering to the one side or the other: But if your Stick-end happens to over-balance, you must pare and diminish it till it comes to an *Equilibrium* with the *Rocket*-end. You have a *Rocket* with this Stick plainly and curiously represented in *Fig. 60*.

*Brecheilius* teaches us a Method (which is easy enough) to find out the proper lengths of these Sticks, in *Chap. 9.* of the Second Part of his *Pyrotechnicks*, as follows: Add one to the number of Fingers that constitutes the length of your *Rocket*, and multiply the Sum by the length of the *Rocket*, and you will have the due length of the Stick: For Example, If the *Rocket* is 8 Fingers in length, add 1 to them and you will have 9, which Number multiplied by 8, which is the length or height of the *Rocket*, will give 72. You must then tie a Stick of so many Fingers in length to your *Rocket*.

*Of Rockets that run upon Lines or Ropes.*

*Sort 1.*

Tie two Iron Rings, or a wooden Tube to a *Rocket* fill'd with a certain Quantity of Ounces of a suitable Composition, and bored as it ought to be; then reave through the Rings, or Tube, the Line which you would have your *Rocket* to run upon. This is the most simple kind; for being arriv'd at the Place, which the duration of its combustible Matter will allow it to reach, it there stops. The following will be much more Artificial, you have this represented in *Fig. 73*.

*Sort 2.*

Fill any particular *Rocket*, whose Orifice may be equal to that of the foregoing (but much longer) to the height of four Diameters, and bore it to the depth of  $3\frac{1}{2}$  Diameters. Then upon this Composition put a Cap, or a little wooden Partition, which must have no Hole through it, and may be glued to the inside of the *Rocket*, or any other way well secured, to prevent the Fire, when it is arrived at that length, from catching hold of the



the Composition contain'd in the other part of the Case. This done, you must charge the remainder of the Rocket to the same height as before, namely, to 4 Diameters,  $3\frac{1}{2}$  of which must be bored. You must then choak the Rocket at top, and make a little Receptacle for the priming as at the other end; or else fit a round piece of Wood to it with an Hole thro' the middle of it, as may be seen in *A*, which must be covered with a little Cap, as you will see distinguished by the same Letter. To this you must add on one Side a Tube made of a very thin Iron Plate, which must be filled with Meal-Powder. Bore a Hole through the Side of the Rocket near the Partition in the middle, and fill it with Meal-Powder; which is done the more readily to convey the Fire thro' the Tube, to the other Receptacle where it lights the Rocket at the other end, and consequently obliges it to return back from whence it came. The upper Part which holds the priming must be covered with Paper, as well as the small Tube that conveys the Fire from the one end of the Rocket to the other. This shall also have a wooden Tube, or two little Iron Rings, to run upon along the Line. You will have the more diversion if you lay small Paper Crackers all round it. The contrivance of this Rocket is very pretty. You have a Representation of it in *Fig. 74*.

*Sorts 3 and 4.*

Take two Rockets of equal length, constructed according to the Method we have already laid down, and let them be bound together with strong Packthread, and let the Head of the one be even with the Choak of the other, and so on alternately, to the end, that the first of them being burned out to the end, it may catch hold of the other and oblige them both to return back again. The extremity by which you intend the first shall fire the other (that is the Neck of the one to the Head of the other) shall be capped with Paper, or any thing else as you see in *Fig. A*; minding to fill the Vacancy of the Cap with slow Composition. In short, you must add a Tube to them to run upon. See them represented by *Fig. 75*, and *76*, by which you will observe a difference between them, the latter having a piece of Wood hollowed on each side to receive them both, and keep them at a little distance from one another, in consideration, that in case the first should chance to burst, the other may receive no danger from it.

Observe here that these Rockets commonly serve to fire several Pyrobolical Machines which are used at rejoycing Occasions. Sometimes also they are disguised under the form of divers Animals, whether fictitious or real, such as flying Dragons, Doves, and other things which you would contrive to vault and run up and down.

In *Fig. 77*, *78*, and *79*, you have three Contrivances for hanging up Sky-Rockets when they are to be fired.

ROD, a Measure of Length containing by Statute just  $16\frac{1}{2}$  Feet *English*. See *Pole*. This must be carefully distinguished from *Rood*, which is a Square Measure containing the fourth part of an Acre.

ROD-Knights, alias *Rad-Knights* were anciently certain Servitors, which held their Land by serving their Lord on Horse-back; or attending him in his Progress or Travels on the Road.

ROLL [in *Law*] signifies a Schedule of Paper or Parchment, which may be turned or wound up with the Hand to the Fashion of a Pipe; of which there are in the Exchequer several Kinds: As, *The great Wardrobe Roll*, *the Cofferer's Roll*, *the Subsidy Roll*, &c.

*Roll of Court*, the Court Roll in a Manor, wherein the Names, Rents, and Services, of the Tenants were copied and enrolled.

RIDDER-roll: The Court *ex officio*, may award a *Certiorari ad informandum conscientiam*; and that which is certified shall be annexed to the Record and is called a *Ridder-roll*.

Or a *Ridder-roll*, is a Schedule or small piece of Parchment, added to some part of a Roll or Record.

ROLLS, or the Office of the Rolls in *Chancery-Lane*, formerly called *Domus Conversorum*, is the House that was built by King *Henry the Third*, for *Jews* converted to the Christian Faith; but *Edward the Third* expelled them for their Wickedness, and deputed the Place for the Custody of the Rolls and Records of the *Chancery*, the Master whereof is the Second in *Chancery*, and in the Absence of the Lord Chancellor or Lord Keeper sits as Judge, being commonly called *the Master of the Rolls*.

ROLLS of *Parliament*, the Manuscript Registers or Rolls of the Proceedings of our old Parliaments. For before the use of Printing, and till the Reign of *Henry the Seventh*, our Statutes were all engross'd in Parchment, and (by vertue of the King's Writ to that purpose) proclaimed openly in every County.

In these Rolls we have a great many decisions of difficult Points in Law, which were frequently in former times referred to the Determination of this Supreme Court, by the Inferior ones of both Benches, &c.

ROMAN *Indiction*. See *Indiction*.

ROMAN *Order of Architecture*, is the same with the *Composite*. 'Twas invented by the *Romans* in the Time of *Augustus*, and set above all the others, to shew (say some) that the *Romans* were Lords over all other Nations: 'Tis made up of the *Ionick*, and *Cerintbian Orders*, and is more ornamental than either.

ROME-Scot was formerly here an annual Tribute of a Penny for every Family, and paid to *Rome* at the Feast of *St. Peter ad Vincula*, being the First of *August*.

*Cambden* tells us it was first granted by *Offa*; but others attribute its Original to *Ina*, King of the *West Saxons*; who being in Pilgrimage at *Rome*, *A. D. 725*. gave it as an Alms, it amounted to three hundred Marks and one Noble yearly. Of this Mark of Slavery to *Rome*, our Ancestors frequently complained as a Burden and Scandal to the *English Nation*: It was first forbidden to be paid by *Edw. 3*. Tho' before complained of in Parliament as a Grievance in *K. John's Time*, *A. D. 1206*. This Payment was abrogated *25 H. 8*. But fervilely restored again *1 and 2 Phil.* and *Mary*; and at last utterly abolished, *1 Eliz. 1*.



ROMPEE, [in *Heraldry*] they call a Chevron so, when it is born of this Figure.

He beareth a *Chevron Rompee*, between three Mulletts, Or, by the Name of *Sault*.

RON-



## 1. The



1. The Index of  $a^7$  (the *First Term*) will be the *Uncia* for  $7 a^6 b$  the *Second Term*.

2. Then  $\frac{7 \times 6}{2} = 21$ . That is the Index of  $a^6$  in the *Second Term* multiplied by its *Uncia* 7; and the Product 42, divided by 2, the Number of Terms to that Place, quotes 21, the *Uncia* of the *Third Term*.

3. Again,  $\frac{21 \times 5}{3} = 35$ . The *Uncia* of the *Fourth Term*, and  $\frac{35 \times 4}{4} = 35$ , will be the *Uncia* of the *Fifth Term*. &c.

4. You may observe here that the *Unciæ* do increase, only 'till the *Indices* of the Two Letters become equal, or change Places; and then the Rest of the *Unciæ* do decrease, as the former increased: So that 'tis enough to find the *Unciæ* of half the Number of Terms in any Power, and then the rest may be easily prefixed.

And when all this is considered, the Value and Expedition of that *Short Theorem* of Sir Isaac Newton, for finding the *Unciæ* of a Binomial, will be understood and admired, *Viz.*

Suppose  $m$  the Exponent of any Power: Then  

$$\text{will } 1 \times \frac{m-0}{1} \times \frac{m-1}{2} \times \frac{m-2}{3} \times \frac{m-3}{4} \times \frac{m-4}{5} \times \frac{m-5}{6} \times \frac{m-6}{7} \times \dots$$
  
 &c. be a *Series* for the *Unciæ* of the Powers of any Binomial involved infinitely.

As, Suppose you would have the *Unciæ* for the 7th Power of  $a + b$ . Then  $m=7$ , and by the Theorem  $1 \times \frac{m-0}{1} = 7$  will be the *Uncia*,

and that  $7 \times \frac{m-1}{2} = 21$  will be the *Uncia* for the *Third Term*: And again, That  $21 \times \frac{m-2}{3} = 35$  will be the *Uncia* for the *Fourth Term*. Also that  $35 \times \frac{m-3}{4} = 35$  will be the *Uncia* of the *Fifth Term*; and consequently by going backwards (as in Art. 4. above) you will find that the *Unciæ* of the two Remaining Terms must be 21, 7, and 1.

*A New, Exact and Easie Method, of finding the Roots of any Equations generally, and that without any previous Reduction. By Mr. Edm. Halley, Geometry Professor at Oxford.*

The principal Use of the *Analytick Art*, is to bring Mathematical Problems to Equations, and to exhibit those Equations in the most simple Terms that can be. But this Art would justly seem in some degree defective, and not sufficiently *Analytical*, if there were not some Methods, by the help of which, the Roots (be they Lines or Numbers) might be gotten from the Equations that are found, and so the Problems in that respect be solved. The Ancients scarce knew any thing in these Matters, beyond *Quadratick Equations*. And what they writ of the *Geometrick Construction* of solid Problems, by the help of the *Pa-*

*rabola*, *Cissoid*, or any other Curve, were only particular things design'd for some particular Cases. But as to *Numerical Extraction*, there is every where a profound Silence; so that whatever we perform now in this kind, is entirely owing to the Inventions of the Moderns.

And first of all, that great Discoverer and Restorer of the Modern Algebra, *Francis Vieta*, about 100 Years since, shew'd a general Method for extracting the Roots of any Equation, which he Publish'd under the Title of, *A Numerical Resolution of Powers*, &c. *Harriot*, *Oughtred*, and others, as well of our own Country, as Foreigners, ought to acknowledge whatsoever they have written upon this Subject, as taken from *Vieta*. But what the Sagacity of Sir *Is. Newton's* Genius has perform'd in this Business, we may rather conjecture (than be fully assur'd of) from that short Specimen given by Dr. *Wallis* in the 94th Chapter of his *Algebra*. And we must be forc'd to expect it 'till his great Modesty shall yield to the Intreaties of his Friends, and suffer those curious Discoveries to see the Light.

Not long since (*viz.* A. D. 1690.) that excellent Person M. *Joseph Raphson*, F. R. S. Publish'd his *Universal Analysis of Equations*, and illustrated his Method by plenty of Examples; by all which he has given Indications of a Mathematical Genius, from which the greatest things may be expected.

By this Example M. *de Lagney*, an Ingenious Professor of Mathematicks at *Paris*, was encourag'd to attempt the same Argument, but he being almost altogether taken up in extracting the Roots of pure Powers (especially the Cubick) adds but little about affected Equations, and that pretty much perplex'd too, and not sufficiently demonstrated. Yet he gives two very compendious Rules for the Approximation of a Cubical Root; one a Rational, and the other an Irrational one. *Ex. gr.* that the side of the Cube  $a a a + b$ , is between

$$a + \frac{a b}{3 a a a + b}, \text{ \& } \sqrt{\frac{1}{4} a a + \frac{b}{a^3}} + \frac{1}{2} a.$$

And the Root of the 5th Power  $a^5 + b$ , he makes

$$= \frac{1}{2} a + \sqrt{\sqrt{\frac{1}{4} a^4 + \frac{b}{5 a}}} - \frac{1}{4} a a \text{ (where note,}$$

that 'tis  $\frac{1}{4} a a$ , not  $\frac{1}{2} a a$ , as 'tis erroneously Printed in the *French Book*.) These Rules were communicated to me by a Friend, I having not seen the Book; but having by Trial found the goodness of them, and admiring the Compendium, I was willing to find out the Demonstration. Which having done, I presently found that the same Method might be accommodated to the Resolution of all sorts of Equations. And I was the rather inclin'd to improve these Rules, because I saw that the whole thing might be Explain'd in a *Synopsis*; and that by this means, at every repeated step of the Calculus, the Figures already found in the Root, would be at least Trebled, which all other ways, are increased but in an equal Number with the given ones. Now, the fore-mentioned Rules are easily demonstrated from the Genesis of the Cube, and the 5th Power. For, supposing the side of any Cube  $= a + e$ , the Cube arising from thence, is  $a a a + 3 a a e + 3 a e e + e e e$ . And consequently, if we suppose  $a a a$  the next less Cube, to any given Non-cubick Number, then  $e e e$  will



be less than Unity, and the Remainder  $b$ , will = the other Members of the Cube,  $3 a a e + 3 a e e + e e e$ . Whence rejecting  $e e e$  upon the account of its smallness, we have  $b = 3 a a e + 3 a e e$ . And since  $a a e$  is much greater than  $a e e$ , the quantity  $\frac{b}{3 a a}$  will not much exceed  $e$ ; so that putting  $e = \frac{b}{3 a a}$  then the quantity  $\frac{b}{3 a a + 3 a e}$  (to which  $e$  is nearly equal) will be found =  $\frac{b}{3 a a + \frac{3 a b}{3 a a}}$  or  $\frac{b}{3 a a + \frac{b}{a}}$  that is  $\frac{a b}{3 a a + b} = e$

And so the side of the Cube  $a a a + b$  will be  $a + \frac{a b}{3 a a + b}$ , which is the *Rational Formula* of M. de Lagney. But now, if  $a a a$  were the next greater Cubick Number to that given, the side of the Cube  $a a a - b$ , will after the same manner be found to be  $a - \frac{a b}{3 a a - b}$ . And this easy and expeditious Approximation to the Cubick Root, is only (a very small matter) erroneous in point of defect, the quantity  $e$ , the Remainder of the Root thus found, coming something less than really 'tis.

As for the *Irrational Formula*, 'tis derived from the same Principle, viz.  $b = 3 a a e + 3 a e e$ , or  $\frac{b}{3 a} = a e + e e$ , and so  $\sqrt{\frac{1}{4} a a + \frac{b}{3 a}} = \frac{1}{2} a + e$ , and  $\sqrt{\frac{1}{4} a a + \frac{b}{3 a}} + \frac{1}{2} a = a + e$ , the Root sought.

Also the side of the Cube  $a a a - b$ , after the same manner will be found to be  $\frac{1}{2} a + \sqrt{\frac{1}{4} a a - \frac{b}{3 a}}$ .

And this *Formula* comes something nearer to the Scope, being erroneous in point of excess, as the other was in defect, and is more accommodated to the Ends of Practice, since the Restitution of the Calculus, is nothing else but the continual Addition or Subtraction of the Quantity  $\frac{a e e}{3 a}$  according as the Quantity  $e$  can be known. So that we should rather write  $\sqrt{\frac{1}{4} a a + \frac{b - e e e}{3 a}} + \frac{1}{2} a$ , in the former Case, and in the latter,  $\frac{1}{2} a + \sqrt{\frac{1}{4} a a + \frac{e e e - b}{3 a}}$ . But by either of the two *Formula's*, the Figures already known in the Root to be extracted, are at least Tripled; which I conclude will be very grateful to all the Students in Arithmetick; and I congratulate the Inventor upon the Account of his Discovery.

But that the Use of these Rules may be the better perceiv'd, I think it proper to subjoin an Example or two. Let it be propos'd to find the side of the double Cube, or  $a a a + b = 2$

Here  $a = 1$ , and  $\frac{b}{3 a} = \frac{1}{3}$ , and so  $\frac{1}{2} + \sqrt{\frac{1}{4} + \frac{1}{3}}$ , or 1, 26, will be found to be the true side nearly. Now, the Cube of 1, 26, is 2, 000 376, and so 0, 63 +  $\sqrt{, 3969 - , 0000 376}$

... 3, 78  
91005291 = 1, 259921049895 —; which in 13 Figures, gives the side of the double Cube, with

very little Trouble, viz. By one only Division and the Extraction of the square Root; when as by the common way of working, how much pains it would have cost, the Skilful very well know. This Calculus a Man may continue as far as he pleases, by encreasing the Square by the Addition of the Quantity  $\frac{e e e}{3 a}$ , which Correction, in this case will give, but the encrease of Unity in the 14th Figure of the Root.

*Examp. 2.* Let it be propos'd to find the sides or a Cube equal to that *English Measure* commonly call'd a Gallon, which contains 231 solid Inches. The next less Cube is 216, whose side  $6 = a$ , and the Remainder  $15 = b$ ; and so for the first Approximation, we have  $3 + \sqrt{9 + \frac{5}{6}} =$  the Root. And since  $\sqrt{9, 8333 -}$

is 3, 1358..., 'tis plain that  $6, 358 = a + e$ . Now, let  $6, 1358 = a$ ; and we shall have then for its Cube 231, 000853894712, and according to the Rule,  $3, 0679 + \sqrt{9, 41201041 - , 000858394712}$   
18, 4070

is most accurately equal to the side of the given Cube, which within the Space of an Hour, I determin'd by Calculation to be 6. 1357924 3966195897, which is exact in the 18th Figure, defective in the 19th. And this *Formula* is deservedly preferable to the *Rationale*, upon the Account of the great Divisor, which is not to be manag'd without a great deal of Labour; whereas the Extraction of the square Root, proceeds much more easily, as manifold Experience has taught me.

But the Rule for the Root of a pure Surfsolid, or the 5th Power, is of something a higher Enquiry, and does much more perfectly yet do the business; for it does at least Quintuple the given Figures in the Root, neither is the Calculus very large or operose. Though the Author no where shews his Method of Invention, or any Demonstration, although it seems to be very much wanting, especially since all things are not right in the printed Book, which may easily deceive the Unskilful. Now the 5th Power of the side  $a + e$  is compos'd of these Members,  $a^5 + 5 a^4 e + 10 a^3 e^2 + 10 a^2 e^3 + 5 a e^4 + e^5 = a^5 + b$ ; from whence  $b = 5 a^4 e + 10 a^3 e^2 + 10 a^2 e^3 + 5 a e^4$ , rejecting  $e^5$  because of its smallness.

Whence  $\frac{b}{5 a} = a^3 e + 2 a^2 e^2 + 2 a e^3 + e^4$ , and adding on both sides  $\frac{1}{4} a^4$ , we shall have  $\sqrt{\frac{1}{4} a^4 + \frac{b}{5 a}}$   
 $\sqrt{= \frac{1}{4} a^4 + a^3 e + 2 a^2 e^2 + 2 a e^3 + e^4 = \frac{1}{2} a a + a e + e e}$ . Then subtracting  $\frac{1}{2} a a$  from both sides,  $\frac{1}{2} a + e$  will =  $\sqrt{\frac{1}{4} a^4 + \frac{b}{5 a} - \frac{1}{4} a a}$ ; to which if

$\frac{1}{2} a$  be added, then will  $a + e = \frac{1}{2} a + \sqrt{\frac{1}{4} a^4 + \frac{b}{5 a} - \frac{1}{4} a a}$   
= the Root of the Power  $a^5 + b$ . But if it had  $a^3 - b$  (the Quantity of  $a$  being too great) the Rule would have been thus,  $\frac{1}{2} a + \sqrt{\frac{1}{4} a^4 - \frac{b}{5 a} - \frac{1}{4} a a}$

and this Rule approaches wonderfully, so that there is hardly any need of Restitution.

But



But while I considered these Things with my self, I light upon a General Method for the *Formula's* of all Powers whatsoever, and (which being handsome and concise enough) I thought I would not conceal from the Publick.

These *Formula's*, (as well the *rational* as the *irrational* ones) are thus.

$$\sqrt{aa + b} = \sqrt{aa + b}, \text{ or } a + \frac{ab}{2aa + \frac{1}{2}b}.$$

$$\sqrt[3]{a^3 + b} = \frac{1}{2}a + \sqrt[3]{\frac{1}{4}aa + \frac{b}{3}a}, \text{ or } a + \frac{ab}{3aa + b}$$

$$\sqrt[4]{a^4 + b} = \frac{3}{2}a + \sqrt[4]{\frac{1}{2}aa + \frac{b}{6}a}, \text{ or } a + \frac{ab}{4a^4 + \frac{3}{2}b}$$

$$\sqrt[5]{a^5 + b} = \frac{3}{2}a + \sqrt[5]{\frac{1}{2}aa + \frac{b}{10}a}, \text{ or } a + \frac{ab}{5a^5 + 2b}$$

$$\sqrt[6]{a^6 + b} = \frac{4}{3}a + \sqrt[6]{\frac{1}{3}aa + \frac{b}{15}a}, \text{ or } a + \frac{ab}{6a^6 + \frac{4}{3}b}$$

$$\sqrt[7]{a^7 + b} = \frac{5}{2}a + \sqrt[7]{\frac{1}{2}aa + \frac{b}{21}a}, \text{ or } a + \frac{ab}{7a^7 + 3b}$$

And so also of the other higher Powers. But if  $a$  were assumed bigger than the Root sought, (which is done with some Advantage, as often as the Power to be resolved, is much nearer the Power of the *next greater* whole Number, than of the *next less*) in this Case, *Mutatis Mutandis*, we shall have the same Expressions of the Roots, *Viz.*

$$\sqrt{aa - b} = \sqrt{aa - b}, \text{ or } a - \frac{ab}{2aa - \frac{1}{2}b}.$$

$$\sqrt[3]{a^3 - b} = \frac{1}{2}a + \sqrt[3]{\frac{1}{4}aa - \frac{b}{3}a}, \text{ or } a - \frac{ab}{3a^3 - b}$$

$$\sqrt[4]{a^4 - b} = \frac{3}{2}a + \sqrt[4]{\frac{1}{2}aa - \frac{b}{6}a}, \text{ or } a - \frac{ab}{4a^4 - \frac{3}{2}b}$$

$$\sqrt[5]{a^5 - b} = \frac{3}{2}a + \sqrt[5]{\frac{1}{2}aa - \frac{b}{10}a}, \text{ or } a - \frac{ab}{5a^5 - 2b}$$

$$\sqrt[6]{a^6 - b} = \frac{4}{3}a + \sqrt[6]{\frac{1}{3}aa - \frac{b}{15}a}, \text{ or } a - \frac{ab}{6a^6 - \frac{4}{3}b}$$

$$\sqrt[7]{a^7 - b} = \frac{5}{2}a + \sqrt[7]{\frac{1}{2}aa - \frac{b}{21}a}, \text{ or } a - \frac{ab}{7a^7 - 3b}$$

And within these two Terms, the true Root is ever found, being something nearer to the *irrational* than the *rational* Expression. But the Quantity  $e$  found by the *irrational Formula*, is always too great, as the Quotient resulting from the *rational Formula*, is always too little. And consequently, if we have  $+b$ , the *irrational Formula* gives the Root something greater than it should be, and the *rational* something less. But contrary-wise if it be  $-b$ .

And thus much may suffice to be said concerning the Extraction of the Roots of pure Powers: which notwithstanding, for common Uses, may be had much more easily by the help of the Logarithms. But when a Root is to be determin'd very accurately, and the Logarithmick Tables will not reach so far, then we must necessarily have recourse to these, or such like Methods. Farther; the Invention and Contemplation of these *Formulae*, leading me to a certain Universal Rule for adfected Equations (which I hope will be of use to all the Students in *Algebra* and *Geometry*) I was willing here to give some account of this Discovery, which I will do with all the perspicuity I can, I had given at N<sup>o</sup> 188 of the *Transactions*, a very ea-

ly and general Construction of all adfected Equations, not exceeding the Biquadratick Power; from which time I had a very great desire of doing the same in Numbers. But quickly after Mr. *Raphson* seem'd in great Measure to have satisfied this Desire, till Mr. *Lagney* by what he had perform'd in his Book, intimated that the thing might be done more compendiously yet. Now, my Method is thus.

Let  $z$  the Root of any Equation, be imagin'd to be compos'd of the parts  $a +$  or  $-e$ , of which let  $a$  be assum'd as near  $z$  as is possible; which is notwithstanding not *necessary*, but only *commodious*. Then from the Quantity  $a + e$  or  $a - e$ , let there be form'd all the Powers of  $z$ , found in the Equation, and the Numerical Co-efficients be respectively affix'd to them: Then let the Power to be resolv'd be subtracted from the Sum of the given Parts (in the first Column where  $e$  is not found) which they call the *Homogeneous Comparationis*, and let the Difference be  $+b$ . In the next place, take the Sum of all the Co-efficients of  $e$  in the second Column, to which put  $=s$ . Lastly, in the third Column let there be put down the Sum of all the Co-efficients of  $e^2$ , which Sum call  $t$ . Then will the Root  $z$  stand thus, in the *rational Formula*, viz.  $z = a + \frac{sb}{ss + tb}$ ; and thus in the *irrational Formula*, viz.

$$z = a + \frac{\frac{1}{2}ss + \sqrt{\frac{1}{4}ss + bt}}{t}; \text{ which perhaps it}$$

may be worth while to illustrate by some Examples. And instead of an *Instrument* let this *Table* serve, which shews the Genesis of the several Powers of  $a + e$ , and, if need be, may easily be continued farther; which, for its use, I may rightly call a *General Analytical Speculum*. The forementioned Powers arising from a continual Multiplication by  $a + e = z$  come out thus with their adjoined Co-efficients: See the Table. But now, if it be  $a - e = z$ , the Table is compos'd of the same Members, only the odd Powers of  $e$ , as  $e$ ,  $e^3$ ,  $e^5$ ,  $e^7$  are Negative, and the even Powers, as  $e^2$ ,  $e^4$ ,  $e^6$ , Affirmative. Also let the Sum of the Co-efficients of the side  $e$ , be  $=s$ ; the Sum of the Co-efficients of the Square  $e^2 = t$ , the Sum of the Co-efficient of  $e^3 = u$ ; of  $e^4 = w$ ; of  $e^5 = x$ ; of  $e^6 = y$ , &c. But now, since  $e$  is supposed only a small Part of the Root that is to be enquir'd, all the Powers of  $e$ , will be much less than the correspondent Powers of  $a$ , and so far the first Hypothesis; all the superior ones may be rejected; and forming a new Equation, by substituting  $a + e = z$ , we shall have (as was said)  $+b = +se + tee$ . The following Examples will make this more clear.

#### Example I.

Let the Equation  $z^4 - 3z^2 + 75z = 10000$ , be propos'd. For the first Hypothesis, let  $a = 10$ , and so we have this Equation,

$$\begin{array}{r} z^4 = + a^4 \quad 4a^3e + 6a^2e^2 \quad 4ae^3 + e^4 \\ - dz^2 = - da^2 \quad dae - de^2 \\ + cz = + ca \quad ce \\ \hline = + 10000 \quad 4000e + 600ee \quad 40e^3 + e^4 \\ \quad - 300 \quad 60e - 3ee \\ \quad + 750 \quad 75e \\ \quad - 10000 \\ \hline + 450 - 4015e + 597ee - 40e^3 + e^4 = 0 \end{array}$$

The



The Signs  $+$  and  $-$  with respect to the Quantities  $e$  and  $e^3$ , are left as doubtful, 'till it be known whether  $e$  be Negative or Affirmative; which thing creates some Difficulty, since that in Equations that have several Roots, the *Hermogenea Comparationis* (as they term them) are oftentimes encreased by the minute quantity  $a$ , and on the contrary, *that* being encreased, *they* are diminished. But the Sign of  $e$  is determin'd from the Sign of the Quantity  $b$ . For taking away the *Resolvend* from the *Homogeneous* form'd of  $a$ ; the Sign of  $se$  (and consequently of the prevailing Parts in the Composition of it) will always be contrary to the Sign of the difference  $b$ . Whence 'twill be plain, whether it must be  $+e$  or  $-e$ ; and consequently whether  $a$  be taken greater or less than the *True Root*. Now the quantity  $e$  is  $= \frac{1}{2}s - \sqrt{\frac{1}{4}ss - bt}$ , when  $b$  and  $t$  have the same Sign,

but when the Signs are different,  $e$  is  $= \sqrt{\frac{1}{4}ss + bt}$

$= \frac{1}{2}s$ . But after it is found that it will be  $-e$ , let the Powers  $e$ ,  $e^3$  and  $e^5$ , &c. in the Affirmative Members of the Equation be made Negative, and in the Negative be made Affirmative; that is, let them be written with the contrary Sign. On the other hand, (if it be  $+e$ ) let those fore-mention'd Powers be made Affirmative in the Affirmative, and the Negative in Negative Members of the Equation.

Now we have in this Example of ours, 10450 instead of the *Resolvend* 10000, or  $b = +450$ , whence it's plain that  $a$  is taken greater than the Truth, and consequently that 'tis  $-e$ . Hence the Equation comes to be,  $10450 - 4015e + 597ee - 4e^3 + e^4 = 10000$ . That is,  $450 - 4015e + 597ee = 0$ ; and so  $450 = 4015e - 597ee$ , or  $b = se - tee$ , whose Root  $e = \frac{1}{2}3 - \sqrt{\frac{1}{4}ss - bt}$ ,

or  $\frac{s}{2t} - \sqrt{\frac{ss}{4tt} - \frac{b}{t}}$ ; that is in the present Case,  $e = \frac{2007\frac{1}{2} - \sqrt{3761406\frac{1}{4}}}{597}$ , from whence we have the Root sought, 9, 886, which is near the Truth. But then substituting this for a second Supposition, there comes  $a + e = z$ , most accurately 9, 8862603936495 .... scarce exceeding the Truth by 2 in the last Figure, viz. when  $\sqrt{\frac{1}{4}ss + bt}$

$= \frac{1}{2}s = e$ . And this (if need be) may be yet much farther verified, by subtracting (if it be  $+e$ ) the Quantity  $\frac{\frac{1}{2}ue^3 + \frac{1}{2}e^4}{\sqrt{\frac{1}{4}ss + tb}}$ , from the Root before found; or (if it be  $-e$ ) by adding  $\frac{\frac{1}{2}ue^3 - \frac{1}{2}e^4}{\sqrt{\frac{1}{4}ss - tb}}$  to that Root. Which Compendium is so much the more valuable, in that sometimes from the first Supposition alone, but always from the second, a Man may continue the Calculus (keeping the same Co-efficients) as far as he pleases. It may be noted, that the fore-mentioned Equation, has also a Negative Root, viz.  $z = 10,26$  .... which any one that has a Mind, may determine more accurately.

### Example II.

Suppose  $z^3 - 17z + 54z = 350$ , and let  $a = 10$ . Then according to the Prescript of the Rule,

$$\begin{aligned} + z^3 &= a^3 + 3a^2e + 3ae^2 + e^3 \\ - dz^2 &= da^2 - 2dae - da^2 \\ + cz &= ca + ce \end{aligned}$$

$$\begin{array}{r} \text{That is, } + 1000 + 300e + 30e^2 + e^3 \\ - 1700 - 340e - 17e^2 \\ + 540 + 54e \\ - 350 \end{array}$$

Or,  $-510 + 14e + 13ee + e^3 = 0$ . Now, since we have  $-510$ , it is plain, that  $a$  is assumed less than the Truth, and consequently that  $e$  is Affirmative. And from (the Equation)

$$510 = 14e + 13e^2, \text{ comes } e = \frac{\sqrt{bt} + \frac{1}{4}ss - \frac{1}{2}s}{t} = \frac{\sqrt{6679} - 7}{13}.$$

Whence  $z = 15, 7 \dots$ , which is too much, because of  $a$  taken wide; therefore Secondly, let  $a = 15$ , and by the like way of

$$\text{Reasoning, we shall find } e = \frac{1}{2}s - \frac{\sqrt{\frac{1}{4}ss - tb}}{t} = \frac{109\frac{1}{2} - \sqrt{11710\frac{1}{4}}}{28}, \text{ and consequently } z =$$

14, 954068. If the Operation were to be repeated the third time, the Root will be found conformable to the Truth as far as the 25th Figure; but he that is contented with fewer, by writing  $tb + te^3$  instead of  $tb$ , or subtracting or adding

$\frac{1}{2}e^3$  to the Root before found, will presently obtain his End. Note, the Equation proposed, is not explicable by any other Root, because the *Resolvend* 350, is greater than the Cube of  $\frac{17}{3}$ , or  $\frac{d}{3}$ .

### Example III.

Let us take the Equation  $z^4 - 80z^3 + 1998z^2 - 14937z + 5000 = 0$ , which Dr. Wallis uses Cap. 62 of his *Algebra*, in the Resolution of a very difficult Arithmetical Problem, where, by *Vieta's* Method, he has obtain'd the Root most accurately; and Mr. Raphson brings it also as an Example of his Method, Page 25, 26. Now this Equation is of the Form, which may have several Affirmative Roots, and (which increases the Difficulty) the Co-efficients are very great in respect of the *Resolvend* given.

But that it may be the easier manag'd, let it be divided, and according to the known Rules of *Pointing*, let  $-z^4 + 8z^3 - 20z^2 + 15z = 0, 5$  (where the Quantity  $z$  is  $\frac{1}{10}$  of  $z$  in the Equation proposed) and for the first Supposition, let  $a = 1$ . Then  $+z^2 - 5e - 2e^2 + 4e^3 - e^4 = 0$ ,  $5 = 0$ ; that is,  $1\frac{1}{2} = 5e + 2ee$ ; hence  $e = \frac{\sqrt{\frac{1}{4}ss + bt} - \frac{1}{2}s}{t}$  is  $= \frac{\sqrt{27} - 5}{4}$ , and so  $z =$

1, 27; Whence 'tis manifest that 12, 7, is near the true Root of the Equation proposed. Now, Secondly, let us suppose  $z = 12, 7$ , and then according to the Directions of the Table of Powers, there arises,

$$\begin{array}{r} \text{b} \quad \quad \quad \text{s} \quad \quad \quad \text{t} \quad \quad \quad \text{u} \\ - 26014,4641 - 8193,532e - 967,74e^2 - 50,8e^3 + 8e^4 \\ + 163870,640 + 38709,60e + 3048e^2 + 80e^3 \\ - 322257,42 - 50749,2e - 1998e^2 \\ + 189699,9 + 14937e \\ = 5000. \end{array}$$

That



That is,  $+ 298, 6559 - 5296 \ 132 \ e + 82, 26 \ e^2 + 29, 2 \ e^3 - e^4 = 0$ ; And so  $- 298, 6559 = - 5296, 132 \ e + 82, 26 \ e \ e$ , whose Root  $e$ . (according to the Rule)  $= \frac{\frac{1}{2} s - \sqrt{\frac{1}{4} s s - b t}}{t}$ , comes

$$\text{to } \frac{2648, 066 - \sqrt{6987686, 106022}}{82, 26} =$$

$05644080331 \dots = e$  less than the Truth. But that it may be corrected, 'tis to be consider'd that  $\frac{\frac{1}{2} u \ e^3 - \frac{1}{2} e^4}{\sqrt{\frac{1}{4} s s - b t}}$ , or  $\frac{0026201 \dots}{2643,423 \dots}$  is,  $00000099$ ,

and consequently  $e$  corrected, is  $= 0564470448$ . And if you desire yet more Figures of the Root, from the  $e$  corrected, let there be made,

$$t \ u \ e^3 - t \ e^4 = 0, 43105602423 \dots, \text{ and}$$

$$\frac{\frac{1}{2} s - \sqrt{\frac{1}{4} s s - b t - t \ u \ e^3 + t \ e^4}}{t}, \text{ or which is all one,}$$

$$\frac{2648, 066 - \sqrt{6987685, 67496597577 \dots}}{82, 26} =$$

$05644179448074402 = e$ ; whence  $a + e = z$  the Root is most accurately  $12, 75644179448074402 \dots$  as Dr. Wallis found in the fore-mentioned Place; where it may be observ'd, that the Repetition of the *Calculus* does ever triple the true Figures in the assumed  $a$ , which the

first Correction, or  $\frac{\frac{1}{2} u \ e^3 - \frac{1}{2} e^4}{\sqrt{\frac{1}{4} s s - b t}}$ , does quintuple;

which is also commodiously done by the *Logarithms*. But the other Correction after the first, does also double the Number of Figures, so that it renders the *assumed* altogether Seven-fold; yet the first Correction is abundantly sufficient for Arithmetical Uses, for the most part.

But as to what is said concerning the Number of Places rightly taken in the Root, I would have it understood so, that when  $a$  is but  $\frac{1}{2}$  part distant from the true Root, then the first Figure is rightly assumed; if it be within  $\frac{1}{100}$  part, then the two first Figures are rightly assumed; if within  $\frac{1}{1000}$ , and then the three first are so; which consequently manag'd according to our Rule, do presently become nine Figures.

It remains now, that I add something concerning our *Rational Formula*, viz.  $e = \frac{s b}{s s + t b}$ ,

which seems expeditious enough, and is not much inferior to the former, since it will triple the given Number of Places. Now having form'd an Equation from  $a + e = z$ , as before, it will presently appear, whether  $a$  be taken greater or less than the Truth; since  $s e$  ought always to have a Sign contrary to the Sign of the Difference of the *Resolvend*, and its *Homogeneal* produced from  $a$ . Then supposing  $+ b + s e + a - t e e = 0$ , the Divisor is  $s s - t b$ , as often as  $t$  and  $b$  have the same Signs; but it is  $s s + b t$ , when they have different ones. But it seems most commodious for

Practice, to write the Theorem thus,  $e = \frac{b}{s}$

$\pm \frac{t b}{s}$  since this way the Thing is done by one Multiplication and two Divisions, which otherwise would require three Multiplications, and one Division.

Let us take now one Example of this Method, from the Root (of the fore-mention'd Equation)  $12, 7 \dots$ , where

$$\begin{array}{r} 298, 6559 - 5296, 132 \ e + 82, 26 \ e \ e + 29, \\ + b \quad \quad - s \quad \quad + t \quad \quad + u \end{array}$$

$2 \ e^3 - e^4 = 0$ , and so  $\frac{b}{s} - \frac{t b}{s} = e$ ; that is, let

it be as  $s$  to  $t$ , so  $b$  to  $\frac{t b}{s} = 5296, 132 ) 298,$

$6559$  into  $82, 26$  ( $4, 63875 \dots$  wherefore the

Divisor is  $s - \frac{t b}{s} = 5291, 49325 \dots$ )  $298,$

$6559$  ( $0, 056441 \dots = e$ , that is, to five true Figures, added to the Root that was taken. But this *Formula* cannot be corrected, as the foregoing *irrational* one was; and so if more Figures of the Root are desired, 'tis the best to make a new Supposition, and repeat the *Calculus* again: And then a new Quotient tripling the known Figures of the Root, will abundantly satisfy even the most Scrupulous.

### ROOTS of Plants are, either

1. *Fibrous*, which send out only small Strings from the Bottom of the Plant distinct from each other.
2. *More thick or Gross*, which have a Body thick and gross, either branched out into Subdivisions or Arms; or else sending out Fibres from it all along.

These last are either

*Carnous*, which are either

1. *Broad and Swelling*.
2. *Long and Slender*, which commonly are more hard and woody.

The *Broad and Swelling* are,

1. *Bulbous*, which consist but of one Globe or Head, and send out Fibres from the Bottom, and are either
  - { *Squamosae*, or *Scaly*, as *Lilies* or *Martagons*.
  - { *Coated*, which are involved in *Skins* or *Coats*, as *Cepa*, *Hyacinthus*, *Allium*, &c.
2. *Tuberous*, which are of a carnous, solid, and like-continued Consistence; and these either,
  1. *Simple*, with but one Globe or Head, as *Rapa*, *Crocus*, &c.
  2. *Manyfold*, as *Asphodelus*, *Paeonia*, &c.

*Long Roots* are either,

1. *Sarmentous*, (i. e) *Twiggy* or *Branching*, which shoot or creep out transverse, or in breadth: Of these some are *Geniculatae*, *Knotty*, or *Jointy*, as *Couch-Grass*, *Mints*, (&c.
2. *Cauliformes*, (i. e) *Stemmy* or *Stalky*, which shoot down deep directly; though often shooting out Fibres and Strings from the great Stem; which also itself is sometimes divided or branching.



ROPES, of a Ship, are in General all her Cordage; But particularly they call by this Name only,

1. The *Entering-rope* which hangs at the Ladder to help the People up the Side.

2. A *Top-rope*, so called, because belonging to the Top.

3. A *Bolt-rope*, into which the Sail is sewed.

4. A *Buoy-rope*, which is that to which the Buoy of the Anchor hangs.

5. The *Guest-rope*, which tows the Long-Boat.

6. The *Keel-rope*.

7. The *Bucket-rope*, which serves to heave the Bucket in drawing Water.

8. The *Rudder-rope*, which reaved into a Hole of the Rudder near the Head, and also through the Stern-post, both the Ends thereof are spliced together, serving to save the Rudder, if by any Accident it should be beaten off.

Also the *Preventer-rope*, which is a small Rope, seized cross over the Ties, close at the Ram-head; so that if any one part of the Tie should be broke, yet the Remainder should not run through the Ram-head to endanger the Yard.

There is also a Rope called a *Breast-rope*, which Lashes the Parrels to the Masts.

And another called the *Guy-rope*, which is reeved through a Block, fastned by a Strop, to the Head of the Fore-mast, and having its end fastened to the Strop of the Winding Tackle, to bowse it forwards, that it may plumb directly over the Hatch Way.

And there is also a *Boat-rope*, by which the Boat hangs, or is fastened a-Stern of the Ship.

ROPE Yarn, is the Yarn of any Rope untwisted: 'Tis commonly made of Cable Ends which are worn out, which are called Junks of the Cables: The Use of it is to serve small Ropes, to make Sinnet Matts, &c. also to make Knettles, which are two of these Rope Yarns untwisted together: Also it helps to make Caburns, i. e. Lines to bind Cables withal; and to fasten the Sails to the Yard Arms, &c.

RORIFERUS *Ductus*, the same that *Ductus Chyliferus*.

ROS, in the Account of the Antients, was the First Moisture that falls from the Extremities of the Vessels, and is dispersed upon the Substance of the Members. *Ros*, says *Galen*, is a Third Sort of Moisture whereby the Parts of our Body are nourished, and is contained in all the Parts of an Animal, like a certain Dew sprinkled upon them. *Blanchard*.

ROS *Vitrioli*, according to *Ang. Sala*, is the first Phlegm or Water that is distilled from Vitriol in *Balneo Mariæ*.

ROSA, the same that *Erysipelas*.

ROSINES, of Vegetables, how made. See *Resine*.

ROSTRIFORMIS *Processus*: See *Coracoides*.

ROSTRUM [in *Chymistry*] is the Nose of an Alembick.

ROTA *Aristotelica*, is the Consideration of a Wheel moving along a Plain, till it hath made one entire Revolution: For then will its Centre have described a Line equal to that of the Circumference of the Wheel, and so will all lesser Concentric Circles. See an *Explication of this* in *Boyle* against *Linus*.

ROTATION, is a Term commonly used in *Geometry* for the Circumvolution, or Motion of any Surface round a fix'd and immoveable Line,

which is called the *Axis* of its *Rotation*. How Solids which are thus, by the Rotation of a Plane round an Axis, generated, may be measured or cubed: The ingenious Mr. *Abr. de Moivre* shews very expeditiously in his *Specimens of the Use of the Doctrine of Fluxions*, Printed in *Phil. Trans. N.* and in Vol. 2. of the *Miscellanea Curiosa*, p. 131 thus: For the Fluxions of such Solids take the Product of the Fluxion of the Abcissa multiplied by the Circular Base: And he gives this Instance: Suppose the Ratio of a Square to the Circle inscribed be as  $\frac{n}{1}$ : the Equation, expressing the Nature or Property of any Circle, whose Diameter is  $d$ ; is  $yy = dx - xx$ . Therefore  $\frac{4dxx - xxx}{n}$

is the Fluxion of a Portion of the Sphere; and consequently the Portion itself  $4\frac{1}{2}dxx - \frac{1}{3}xxx$ ;

And the Circumscribed Cylinder is  $\frac{4dxx - x^3}{n}$

Therefore the Portion of the Sphere is to the Circumscribed Cylinder, as  $\frac{1}{2}d - \frac{1}{3}x$  to  $d - x$ .

ROTATOR *Femoris Extrorsum*: See *Obturator Externus*.

ROTATOR *Majon* & *Minor*, are two *Apophyses* in the upper Part of the Thigh-Bone, called *Trochanteres*, in which the Tendons of many Muscles are terminated.

ROTHER-NAILES, or *Rudder-Nails*, are such as have a very full Head; and are used to fasten the *Rudder-Irons* in Ships.

ROTULA, the same that *Mola genu*.

ROTULÆ: See *Tabella*.

ROTUNDUS, (*Sc. Musculus*) is a Muscle of the Radius, serving to turn the Palm of the Hand downwards.

ROUND-House, is the uppermost Room or Cabin on the Stern of the Ship where the Master lies.

ROUND-in, or *Round-ast*, a Term at Sea belonging to the Main and Fore-Sail: When the Wind largeth, they say, *Let rise the Main-tacks, or the Fore-tacks! Haul ast the Fore-sheet to the Cat-head; and the Main-sheet to the Cubbridge-head!* And when these Sheets are thus haled down, they keep them from flying up with the *Passarado-rope*. This Work is called, *rounding-in*, or *rounding-ast* the Sail.

ROUNDNESS: The round Globular or Spherical Form, which Pebbles, Fruits, Berries, &c. are adorned with; and which Drops of Water or Quick-silver, &c. Bubbles of Air under Water or some such Liquor, melted Oil, &c. do generally put on, seems to arise from the Incongruity of their Particles, with those of the ambient Fluid; which prevents them from coalescing together, and by pressing upon them, and environing them all round equally, turns them into a round Form. This seems plain, as *Dr. Hook* hath long ago well observed from the way of making small round Shot of several Sizes, without casting the Lead into any Molds, from Drops of Rain being formed in their falling into round Hail-stones; and from a Drop of Water falling upon small Sand, or Dust, which will strait produce an artificial round Stone: And from the small round red-hot Balls (easily seen with a Microscope) which are formed by the Collision and Fusion of the Flint and Steel in striking Fire, and perhaps the Principle of Gravitation, is principally concerned in this Matter.

ROUNDS,



**ROUNDS**, in a Garrison, is a *Night-Watch* commanded by an Officer that goes round the Rampart of the Garrison, in order to listen if any thing be stirring without the Works, to see that the Centries are watchful, and upon Duty, and that all Things be in good Order. In strict Garrisons, the *Rounds* go every Quarter of an Hour, that the Rampart may be still furnished. The Centries ought to *challenge* at a Distance; and to rest their Arms as the *Rounds* pass, and to let no one come near them. When the *Round* is near the *Corps de Garde*, the Centry calls aloud, *Who comes there?* And when the Answer is, *The Round*, he says, *Stand*; and then calls for the Corporal of the Guard, who draws his Sword, and calls also, *Who comes there?* And when 'tis answered, *The Rounds*; he that hath the Word must advance, and deliver the Word to the Corporal, who receives it with his Sword pointed at the Giver's Breast.

**ROUT**, [in the *Law-sense*] is an Assembly of three or more Persons, who are going forcibly to commit an unlawful Act, though they do it not: For if it be done 'tis a *Riot*.

**ROWLE**, [in a *Ship*] is a round Piece of Wood or Iron, wherein the Whip goes, being made to turn about, that it may carry over the Whip the easier from Side to Side.

**ROWSE** in the *Cable*, or *Rowse* in the *Hawser*, is a Word of Command at Sea, when a Cable or Hawser lies too slack in the Water, and they would have it be made more *taught*; lest on the turning of the Tide, the Cable should happen to be foul of the Anchor.

**ROYAL Assent**, is that *Assent* which the King gives to a Thing formerly done by others, to the Election of a Bishop by Dean and Chapter; which given, then he sends a Special Writ for the taking of *Fealty*.

And also to a Bill passed in both Houses of Parliament; which *Assent*, in Parliament, being once given, the Bill is indorsed with these Words, *Le Roy le veult*, i. e. *It pleases the King*: But if he refuses to agree to it, then thus; *Le Roy S'avisera*, i. e. *The King will advise*.

**ROYAL Fort**: See *Fort*.

**ROYAL Parapet**, or, *Parapet of the Rampire*, [in *Fortification*,] is a Bank about three Fathoms broad, and six Foot high, placed upon the Brink of the Rampire, towards the Country, to cover those who defend the Rampire.

**RUBIGO**, or *Mildew*, is a Disease happening to Plants, caused by a dewy Moisture, which falling upon them, and continuing there for want of sufficient Heat of the Sun to draw it up, doth by it's Sharpness, or Acrimony, scorch and corrupt the inmost Substance of the Plant.

**RUBRICA**: See *Impetigo*.

**RUCTION**, or Belching, is a depraved Motion of the Stomach, occasioned by an Effervescence there, whereby Vapours and flatulent Matter are sent out at the Mouth. *Blanchard*.

**RUDDER of a Ship**, is a Piece of Timber hung on the Stern-posts by four or five Iron Hooks (called *Pintles*) and is as it were the Bridle of a Ship; because by it she is turned about at the Pleasure of him that stands at the Helm. A narrow Rudder is best for a Ship's Sailing, provided she can feel it; that is, be guided and turned by such a Rudder. For a broad Rudder will hold much Wa-

ter, when the Helm is put over to any Side: But yet if a Ship have a Fat Quarter, so that the Water cannot come quick and strong to her Rudder, she will require a broad Rudder. The aftermost Part of the Rudder is called, the *Rake of the Rudder*.

**RUDDER of a Ship**: The *French* Author of a late Book about the handling or working of Ships at Sea, in *Chapt. 7*. proposes to demonstrate what the Angle is, which the Rudder of a Ship ought to make with her Keel, in order to *Stay* or *Bear up*, the soonest that is possible: And he saith the Tiller of a Rudder ought to make with the Keel an Angle of nearly 55 Degrees. And in order that this may be precisely done, he advises to put a Cleat on the Sweep in the Gun-Room, and to dispose it so, that the Arch contain'd between the Keel and Cleat, may be of this Number of Degrees; and that the Tiller of the Rudder ought to be some how stopp'd, so that it cannot go beyond this Mark; for if it passes it, it will do more hurt than good.

**RUDDER Irons**, are the Cheeks of that Iron, whereof the Pintle is part, which is fastened and nailed down about the Rake of the Rudder.

**RUDDER-Rope**: *Vide Rope*.

**RUGITUS**, is an Effervescence of Chyle and Excrements in the Blood, whereby Wind and several other Motions are excited in the Guts, and rowl up and down the Excrements, when there's no easy Vent upwards or downwards. *Blanchard*.

**RULE of Falshood**: See *Position*.

**RULE of Three**, or the *Rule of Proportion*; or as it is called, from its excellent Use, *The Golden Rule*, is that which teaches to find a Fourth Number, which shall have the same Proportion to one of the three Numbers given, as the others have to one another.

This *Rule of Three* is, 1. *Direct*. 2. *Indirect*. 3. *Double-Rule Direct*. 4. *Double-Rule Indirect*.

*Rule of Three Direct* finds a fourth Number in such Proportion to the third, as the second is to the first; or, as the first is to the second, so is the third to the fourth: Thus.

$$1 : 2 :: 3 : 6$$

This Rule requires (and is to be known thus: That if the second Term be greater or less than the first, the fourth Term shall be likewise greater or lesser than the third.

Or, in the Question, if more require more, or less require less, then use this *Rule Direct*, and multiply the second and third Terms together, and divide the Product by the first Term, the Quotient gives the fourth Term required.

*Note*, That the first and third Terms, and the second and fourth, are of the same Denomination: As if the first be of Money, Weights, or Measures, &c. so shall the third; and so as the second, the fourth.

*Example*.

*If 4 Yards cost 8s. What will 6 Yards cost?*

*Answer*, 12.

$$\begin{array}{cccc} r. & s. & y. & s. \\ \text{For } 4 : 8 :: 6 : 12 \end{array}$$

Here (according to the Rule  $8 \times 6 = 48$ , which divided by 4, gives 12 required.

Observe,



Observe, That the Term which makes the Question, is to be set in the third Place, and that which is of like Name with it, set in the first Place, and the Numbers remaining set in the second, of whose Nature the Number sought must always be.

In this Rule, if you multiply the second and third Terms together, the Product shall be equal to the Product of the first Term multiplied by the fourth; which may very well serve for a Proof, if required.

**RULE of Three Indirect, or the Backward Rule,** is known by being contrary to the *Direct*; for whereas the former required, that more shall have more, and less less; as if 4 Yards cost 2s. 8 Yards will cost more than 2s. because it is double to 4 Yards, and so must the Answer be double to 2s. that is 4s.

But in this Rule, more will require less, and less more; as if 4 Horses in 6 Days eat 10 Bushels of Oats, 8 Horses will eat 10 Bushels in a fewer Quantity of Days, viz. in 3. Here 10 Bushels being common is omitted, and the Question stands thus:

$$4 : 6 :: 8 : 3$$

Here the third Term contains the first, as often as the second doth the fourth: Therefore the Product of the first and second divided by the third, gives the fourth.

As  $\frac{4 \times 6}{8} = 3$ , that  $\frac{24}{8} = 3$ , the fourth Term required.

The *Double Rule of Three*, both *Direct* and *Indirect*, may be comprised in one Rule, with two Operations only.

1. Observing, That the given Terms are always five, whereof three are Conditional and Antecedent, or Suppositions, the other two demand the Question, and are Consequents answering some of the former Antecedents; infomuch, that with the Answer there will be as many Consequents as Antecedents, which must match one another in the same Denomination exactly.

2. For the right placing of the Question and Terms, the three Terms of the Conditional Part are duly to be regarded: Let that which is the Principal Cause of Loss or Gain, Increase or Decrease, Action or Passion, be put in the first Place; and that which betokeneth the Space of Time, Distance of Place, &c. be put in a second Place; and the remaining Part in the third. The Conditional Part thus stated, the other two Terms wherein the Demand lies, must be placed so under the former Terms, that they may correspond one with another.

### R U L E I.

Then, If the Blank or Place sought, fall under the third Term, multiply the three last Terms for a Dividend, and the two first for a Divisor, and the Quotient gives the sixth Term required.

### R U L E II.

But, If the Blank fall under the first or second Terms, multiply the first, second, and fifth Terms for a Dividend, and the third and fourth for a Divisor, the Quotient gives the Answer.

#### Example 1.

If 12 Rods of Ditching be done by 2 Men in 6 Days, how many Rods shall be wrought by 8 Men in 24 Days?

Answer, 194.

State your Numbers according to the former Direction, they'll stand thus; the Blank under the third Place.

| Men. | Days. | Rods. |
|------|-------|-------|
| 2    | 6     | 12    |
| 8    | 24    |       |

Therefore (by the first Rule)  $12 \times 8 \times 24 = 2304$  for the Dividend, and  $2 \times 6 = 12$  for the Divisor; the Quotient 194 gives the Answer.

#### Example 2.

If 2 Men work 12 Rods in 6 Days, how many Men will work 192 Rods in 24 Days?

Answer, 8.

Your Terms being rightly placed, the Blank will fall under the first Term thus:

| Men. | Days. | Rods. |
|------|-------|-------|
| 2    | 6     | 12    |
|      | 24    | 192   |

Here  $2 \times 6 \times 192 = 2304$  is the Dividend, and  $12 \times 24 = 288$  is the Divisor, and the Quotient 8 is the Answer.

**RULE-Sliding.** Of this useful and ready Instrument there are several Sorts made; as one by *Partridge*, another by *Everard*, a third by *Hunt*: The Ground and Reason of all which is one and the same; as may be seen in the several Treatises written by the Authors above-named; to explain and shew the Use of the several Rules. I shall give you here in short the several Uses and Advantages of all of them.

*Seth Partridge* calls his the *Double Scale of Proportion*; because the Scales or Lines upon it are all *Double*, which are the Lines usually call'd the *Artificial Lines*, of *Numbers*, *Sines*, and *Tangents*; whose Invention and Use is owing to Mr. *Gunter*: These you will find described, and their Nature explained, in this *Lexicon*, under these Words. On the Sides of his *Double Scale*, are usually set a Line of Inches; or of Foot and Inch-measure; and there may be put a *Gage-Line*, a *Meridian-Line*, and a Scale of Equal Parts, *Lines of Chords*, and for Board or Timber-Measure, according as any one pleases, or his Occasions require.

*Everard's* and *Hunt's* Sliding-Rules, are thicker and squarer, so that there are two Sliding-Pieces, which can be fitted to either Face of the Rule; on one of which there are usually two double Lines of



of Numbers, made to slide against such another double Line placed above them marked O, and a single Line of Numbers placed below mark'd D. These in *Everard's*, which I shall describe, are marked with B and C, and on the Back of this Sliding-Piece, is a treble Line of Numbers marked E, together with a Line of Segments.

The other Sliding-Piece hath on one Side a Line of Artificial Sines and Tangents, to slide against two such other on the Sides; and on the other Side is another such Line of Sines, and a Line of versed Sines. Either of these *Sliders* are made to fit in, on each Face of the Rule.

On one Edge or Side of the Rule, are usually placed the Natural Lines of Chords, Sines, Tangents and Secants, for Spherick Projection, with a small Scale of Equal Parts; and one of *Latitudes*, *Hours*, and *Inclination of Meridians*, for Dialling: As also a Line of *Rumbs*, and M. L. for Navigation: And on the other Side or Edge, besides Inches and Foot-Measure, is a large Scale of Equal Parts, with a *Meridian Line* placed by, to graduate Sea Charts, &c. The Uses of all which, you will find under their *Names*.

The first Thing to be learned on the Scale, or Rule, is how to count or number, in the several Lines of Numbers; for as for Sines, Tangents, &c. these all are easy.

1. Know then that every Line of Numbers is a Line of Geometrick Proportion, divided first into 9 Unequal Parts, which may be called *Primes*; these are marked with the 9 Digits, 1, 2, 3, 4, 5, &c. Each of these *Primes* is subdivided into ten other Parts, called *Tenths*: And each *Tenth* is either divided, or supposed to be so, into ten other Parts, which may be called *Centesms*, or Hundredth-Parts.

In *Everard's* Rule, the Line D being about 11 Inches long, hath each *Tenth* in the first Prime, divided Actually into Ten Parts. But between 2 and 4 each *Tenth* is divided into but Five Parts; each of which there is one Fifth of an Hundred, or 20. Between 4 and the End of the Line, every *Tenth* is divided only into Two Parts, so that each Part is 50, or the Half of an Hundred. You may imagine or suppose also that each *Centesm* is subdivided into Ten Parts; which therefore will be *Thousandths*, &c.

The Figures 1, 2, 3, 4, 5, &c. by which the Primes are distinguished, are all Arbitrary Points; and may each of them represent so many entire Units, Tens, Hundreds, Thousands, &c. or so many Tenths, Hundredths, Thousandths, or Ten Thousandth Parts of an Unit.

2. Wherefore in Whole Numbers, if 1, at the beginning of the Line D signify an *Unit*: Then 2, 3, 4, and 5, &c. will also signify or stand for so many *Units*, and the *Tenths*, and *Centesms*, both be accordingly *Decimal*, or *Centesimal* Parts. If 1, then represent Ten Units, then the *Primes* 2, 3, 4, &c. will signify 20, 30, or 40. If 1, stand for 10, or 100. accordingly, the other Figures, will be 200, 300, 400; or 2000, 3000, 4000, &c.

3. In *Decimals*, If 10 in the Line D represent 1, then each *Prime* reckon'd backwards towards the Left-hand, will be (1) one *Tenth*; and in those *Primes* each *Tenth* will be .01, and in those

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*Tenths*, each *Centesm* will .001, &c. Part of an *Unit*.

To explain this a little further, draw out the Sliding-Piece B: Till 1, at the beginning of B, stand exactly at 10, at the End of the Line A, for then you will have a Line of Numbers, four times repeated; of which let 1, at the beginning of A, stand for 1, or Unity. Then will the next 1, in the Middle of the Line A, stand for 10, and 10 at the End of A, or beginning of B, will represent 100, (1) in the Middle of B, will be 1000; and 10 at its End will stand for 10000.

On the contrary, if you suppose 10 at the End of the fourth Radius in B, to represent (1) then each *Prime* in that fourth *Radius*, will be .1 (one *Tenth*,) in the third *Radius* 'twill be .01; as the second, .001, and in the first, .0001 Parts of an *Unit*.

So also 2, in the first *Radius* will be .0002; in the second *Radius* .002, in the third .02, and in the fourth .2 of an *Unit*.

4. All which being well understood, and considered, which a little Practice will render easy, 'twill be easy to distinguish that Point on the Line where any Number given, *Integer*, or *Decimal* Part, is represented. Thus you will find that the Point *ag*, on the Line D, represents 1895 *Units*; and the Point *wg*, represents 1715. But on a Line of this Length, you can't distinguish any Number, if it have above four Places, to any Exactness: For all the Figures further will be represented at the same Point: Thus, if 189562 were required, you can have on the Rule only 1895.

All Numbers which after the first Figure have only Cyphers, are represented at the same Point: As 20, 200, 2000, &c. are all represented by 2. If a Number of three Places, hath a Cypher for the middle Figure: As suppose 308, you must count 3 on the Line (at the third *Prime*) and then counting no *Tenths*, for the last Figure 8, you must reckon 8 *Centesms*, or Hundredth-Parts.

If two Cyphers are in the middle of a Number of four Places; as suppose 4005: After 4, you must neither go on to account *Tenths*, nor *Hundreds*, but for the last Figure 5, you must reckon so many Thousandth-Parts.

#### Of the Uses of the Sliding-Rule.

1. To multiply one Number by another; As, suppose 68 by 26.

As 1. 26 :: 68. 1768.

Set 1, on the Line A, against 26, on B, and then against 68 on A, you will find the Product 1768, on B.

You may begin with either Factor, as a Multiplier; and the Product will have as many Places as are in both Factors; except the two first Figures exceed, or are greater than the least Factor; and then it will have one less, as in multiplying 68 by 14,

As 1. 14 :: 68. 952.

Where the Product 952 hath but three Places; because the Figures 1 and 4 in 14, are both less than 9 and 5 in 952.

2. To multiply *Decimal Fractions*, or *Mixt Numbers*;

As 27. 8 and .8.

5 E e e e

Make



Make the Mixt Number, or Whole one (if such there be) the Multiplier; and setting it on B, against 1 in A: Seek the Product towards the Left-hand against .8 on B; which will be 22 in A.

3. To divide one Number by another; as 750 by 25.

In Division, As 25. 1 :: 750. 30, the Quotient. Set 25 on B, against 1 on A; and then against 750, on B, will be 30, the Quotient upon A.

N. B. These Examples will instruct you, that at one setting of the Rule, you do both multiply and divide.

As suppose 25 a Multiplier; set 1, on B, against 25, on A; and then against any Multiplier in B, you have the Product on A.

And without moving the Rule, if you suppose 25 to be a Divisor against any Dividend on A, you will have a proper Quotient in B.

4. Having, Two, Three, Four, &c. Numbers given, to find a Third, Fourth, Fifth, &c. in Geometrical Proportion to them: Let the Numbers be 2, and 4.

Set 2 in B, against 4 in A, and then you will find against 4 in B, there will be 8 in A; against 8 in B, 16 in A; against 16 in B, 32 in A, &c. and so you may go on either forward or backward, as far as you please.

5. To reduce Vulgar Fractions to Decimals:

As, suppose  $\frac{63}{84}$ .

Set 84 in B, against 63 in A; and then against 1 in B, you will have .75, the Decimal required. And 'tis .75, not 75, because 'tis on the Left-hand of Unity, or 1 in A.

6. To reduce .7625 a Decimal Fraction to the known Parts of an Integer.

First let the Decimal of a Pound be reduced to Shillings, Pence or Farthings.

Set 1 in the Middle, or 10 at the End of B, against 20 (the Shillings in a Pound) in A; and then against .7625 in B, you will have 15. 25 in A: That is, 15 s. 3 d.

If you would have reduced it to Pence, you must have set 1 in B, against 240 (the Pence in a Pound) in A, you would have had 183, the Pence in .7625.

If you would have the Farthings, set 960 (the Farthings in a Pound) in B, against 1 in A, and then against the Decimal .7652 in B, you have 732, the Farthings contained in it, on A.

If .7625 were the Decimal of an Ale Barrel, set 32 (the Gallons in a Barrel of Ale) in B, against 1 at the beginning of A; and then against .7625 in A, will be 24. 4. the Gallons in that Fraction.

7. To work the Rule of Three, or three Numbers being given, to find a fourth Proportion, either directly or inversely.

1. Directly.

If 6 Quarters of Malt make 18 Barrels of Beer, how much will 30 make?

Set 6 on B, to 18 on A, and then against 30 on B, you will have the fourth Term, 9 on A.

2. Inversely.

If 8 Men can do a Piece of Work in 9 Days, in how many Days would 12 Men dispatch the same Work?

Set 12 on A, to 8 on B; and then against 9 on A, will be 6 on B, which is the fourth Number sought.

3. If the Question had been in how many Days could 6 Men have done the same Work? then 'twould have been, as 6 on B, to 8 on A :: So 9 upon B, to 12 upon A.

8. Between two Numbers given, to find a mean Geometrical Proportional.

Suppose 50 and 72.

Set 50 in C, against 50 in D, and then against 72 in C, will be 60 in D, the mean required; or set 72 on C, against 72 on D; and then against 50 on C, will be 60 on D.

9. To extract the Square Root of any Number under 1000000.

Apply the Lines C and D; so that 10 at the End of C be against 1 in D, and then will the Square Root of any Number in C, be found by Inspection against it in D.

Only observe when the Number of Places in the given Number is even, i. e. when the Number consists of 2, 4, 6, or 8 Figures (being Integers) you must find it in the second Radius of the Line C; and against it you have the Root in D: Thus against 16 in C, you will find 4 in D, against 81 in C, 9 in D.

Against 2304 in C, 48 in D; and against 784996 in C, you will have 886 in D, as well as those Numbers can be expressed on the Rule: And in this Case the Root will always consist of half as many Figures as the Number given.

But if the Integers in the Number given are odd, as 1, 3, 5, or 7; then it must be sought in the first Radius on C, and against it in D will be the Root sought. So bring 1 at the beginning of C, to 1 in the middle of D; and then against 576 in C, will be 24 in D, and against 20736 in C, will be its Square Root 144 in D.

10. To extract the Cube Root of any Number under 1000000000.

Apply the Triple Line of Numbers E against D, as C was in the Square Root; and then against any Numbers in E, are the corresponding Cube Roots in D.

N. B. When the Number consists of 1, 4, or 7 Places, you must find it in the first Radius in E.

But when it hath 2, 5, or 8 Places, it must be found in the second Radius of E.

As if it have 3, 6, or 9 Integers, it must be found in the third Radius.

11. Either the Diameter or Circumference of a Circle being given, to find the other.

When the Diameter is 1 Inch, Yard, Foot, &c. the Circumference is 3.1415 of such Inches, Yards, Feet, &c.

Where-



Wherefore as 1, to 3. 1415 :: So is the Diameter of any Circle to its Circumference.

Set therefore 1, on A, to 3. 1415 on B; and then against any Diameter in A, you have the corresponding Circumference in B, and *vice versa*.

12. Having the Diameter to find the Area of a Circle.

Set 1 on D, to .7854 on C; and then against the Diameter in Inches on D. (Suppose 20,) you will have the Area in Square Inches, (*viz.* in this Case 314. 15.) on C; and so against any Diameter in D, you will have a corresponding Area in C.

13. To three Numbers given to find a fourth in triplicate Proportion.

If a Bullet whose Diameter is 4 Inches, weigh 9 lb. What will one of the same Matter weigh, whose Diameter is 8?

Set 4 in A against 8 in B; and then against 9 in A you have 18 in B, against 18 in A 36 in B; and against 36 in A 72 in B; which third Number in continual Proportion from 18, is the Number sought, shewing the Weight of such a Bullet to be 72 lb.

Simple Interest.

14. Given Principal, Time, and Rate, required the Amount.

What doth 15 l. 5 amount to in 12 Years Time at 6 per Centum?

Set 1 in A to 6 in B; and then against 12 in A, you have 72 in B; which because it was .06, will be .72 the Interest of one Pound for 12 Years at 6 per Cent. Then set .72 in B, against 1 in A; and you will have against A 15. 5 in A, 26. 66: the Amount in B. And so from any Three of these given, you may find the Fourth.

15. Given an Annuity, Time, and Rate; to find the Amount.

What is the Amount of an Annuity of 62 Pounds per Annum, at 6 per Cent. at 4 Years End?

1. Set 1 on B to 6 on A; and then against 62 in B will be 3. 72, the Interest of 62 l. for one Year.

2. Set 1 on B to 3. 72 in A; and then against 1 in B (*viz.* half the Time given) will be 7. 44, the Interest of the Annuity for half the Time in A.

3. Set 1 on B to 7. 44 in A; and then against 3 in B (then all the given Years but one) to 22. 32 the Interest of the Annuity in A.

To which adding 248, (the Sum of the 4 Annual Payments) the Sum will be 270. 32. The whole Amount.

Compound Interest.

In Compound Interest the Respective amounts for each Respective Year, are so many Geometrick Mean Proportional Numbers.

For as 100 l. at the End of the First Year is 106 l. at 6 per Cent. and that is now become a Principal; and at the second Years End will amount to 112 l. 36. and this being made a Principal will at the third Years End amount to 119 l. 10 16; and these four Numbers 100. 106. 112. 36, and 119. 10 16, are in Geometrick Proportion continued.

Wherefore 'tis easy by the Rule to solve this Problem.

16. Of any Sum of Money to find the Amount in any Time, and at any Rate of Compound Interest.

As suppose the Amount of 100 l. for 5 Years at 6 per Cent. Compound Interest.

Set 100 on B against 106, (or 108, &c. according to the first Years Amount at any Rate of Interest) and then against 106 on B, you will have 112 l. 36. the Amount in two Years; and against 112. 36. on B, will be 119 l. 10 16 on A, the Amount in three Years; and against 119. 10 16 in B, will be 126. 247, the Amount in four Years. And lastly, against 126. 247 in B, you will have 133 l. 822 on A, which is the whole Amount at the five Years End.

And from it 'twill be easy to answer this Question.

17. What is a Sum worth now in ready Money, which is due at any Time to come, and at any Rate of Interest?

As what is the present Value of 133 l. 822 due five Years hence, at 6 per Cent. Compound Interest?

For you need only reverse the former Practice: Set therefore 106 on A against 100 on B; and then against 133 l. 822 on A, you will have 126. 247 on B; which is the Worth of 133. 822 at the End of the first Year: Then against that on A, you will have 119. 10 16 on B, for the present Worth at the End of the second Year; and against 119. 10 16 on A, you will have 112. 36 on B, for the third Year; and against that Number on A, you will have 106 on B for the fourth Year; and at last against 106 on A, you will have 100 l. on B; which is the present Worth of 133 l. 822 due five Years hence at Compound Interest of 6 per Cent.

18. What are the Arrears due on an Annuity or Rent of 9 l. per Annum, and forborn 12 Years, at the Rate of 6 per Cent. Compound Interest?

Set 6 in A to 100 in B; and then against 9 in A will be 150 in B; which is a Principal whose Interest is 9 l. Then work as in Problem 16 above, to find the Amount of 150 l. in twelve Years, which will be 301 l. 828; from which you must deduct 150 l. (the Principal first found) and the Remainder 151. 828 answers the Question, and is the Sum of the Arrears sought.



19. *What is the ready Money worth of a Rent or Annuity of 9l. per Annum, to continue for twelve Years only; allowing the Buyer to have 6 per Cent. for his Money, Compound Interest?*

By the last Question the Arrears of a Rent of 9l. per Ann. and forborn for twelve Years were 151l. 828.

And the present Worth of 151l. 828. (by Quest. 17.) due at the End of twelve Years, is 75l. 443. Wherefore so much may be given for an Annuity of 9l. per Ann. to continue for twelve Years.

*N. B.* If the Annuity is not to commence till after a certain Number of Years; as suppose 6 are expired: Then you must add that Term to the twelve Years, which makes it 18. Then seek what the Arrears, of 151l. 828 being forborn eighteen Years, are now worth in ready Money, which (by Quest. 18.) you will find 53l. 185, which is the Answer; So that a yearly Rent of 9l. to begin six Years hence, and to continue twelve Years, is in ready Money worth but 53l. 185; whereas if it were to commence immediately, 'twere worth 73l. 443.

*Purchasing of Annuity.*

20. *What Annuity, to continue twelve Years, will 300l. buy; allowing the Buyer 6 per Centum, Compound Interest for his Purchase Money?*

By Quest. 19. I find that 75l. 443 will purchase 9l. per Ann. for twelve Years, (or you may find the Value of any other Annuity in ready Money) and then say, as the present Worth or Value, is to the Annuity taken :: So is the Sum proposed to the Annuity required.

Set therefore 75l. 443 on B to 9 on A; and then against 300l. on B, will be 35l. 776, or 35l. 15s. 6d. and such an Annuity to continue twelve Years to come, is worth now in ready Money 300l.

21. *What is the Value of a Freehold Estate of 75l. per Ann. allowing the Buyer 6 per Cent. for his Money, Compound Interest?*

As the annual Interest of 1l. is to 1l. :: So will the annual Rent be to the Sum required.

Wherefore against .06 on B, set 1 on A; and then against 78 on B, you will have 1300 on A, the Value of the Estate required.

*In Trigonometry.*

It will be very easy to work any Cases or Questions by this Sliding-Rule; in either Plain or Spherick Triangles; of which one Instance in each will be sufficient.

Suppose the common Case in Plain Sailing.

22. *Where Course and Distance are given; and Difference of Latitude and Departure are required. (See Plain-Sailing.)*

The Canon is, As Rad. to Distance run in Miles :: So Co-sine of the Course to Difference

of Latitude in Miles :: And so Sine of the Course to Departure in Miles.

Bring then 90° in the Line of Sines against 108 (the Distance run) in A; and then against 56° 15' (the Co-sine of the Course) in the said Line of Sines, you will have 90<sup>m</sup> in A, the Difference of Latitude in Miles.

If you would have the *Departure*.

Bring as before 90° in the Line of Sines against 108 in A; and against 33° 45' (the Angle of the Course) in the Sines will be 60 Miles in A, the Departure required.

Suppose 2dly. The Sun's Place in the Ecliptick to be 30° of  $\gamma$ , and his greatest Declination to be 20° 30', I require his present Declination.

The Canon is, As Rad. Sine of the Sun's Longitude or Distance from  $\gamma$  :: So Sine of greatest Declination to Sine of the present Declination.

Set therefore 90° in the Sliding-Line of Sines against 30° in the fix'd one; and then against 23° 30' in the Sliding-Line, you will find 11° 30' in the fix'd Line of Sines; which is the Sun's Declination sought.

*In Dialling.*

23. *To calculate the Horary Distances from the Meridian, in either horizontal or particular Dials.*

The Canon is, As Rad. to Tangent of 15° (one Hours Equinoctial Distance) :: So is the Sine, or Co-sine, of the Latitude, suppose 51° 30' of the Place, to the Tangent of the Distance sought 11° 51'.

Set 90° in the Sliding-Sine to 15° in the fix'd Tangent; and then against 15° 30' in that Sine, will be 11° 51' in the Tangent.

RUMB, or *Course of a Ship*, is the Angle which she makes in her Sailing with the Meridian of the Place where she is.

*Complement of the Rumb*, is the Angle made with any Parallel to the Equator by the Line of the Ship's-run.

RUMB, [in Navigation,] is one Point of the Compass, or 11  $\frac{1}{4}$  Degrees, viz. the  $\frac{1}{4}$  Part of the Circumference of the *Horizon* or *Compass Card*, which is the Representative of the *Horizon*.

RUMB-Line, is a Line described by the Ship's Motion on the Surface of the Sea, steered by the Compass, making the same or equal Angles with every *Meridian*.

The *Rumbs* are *Helispherical* or *Spiral Lines*, proceeding from the Point where we stand, winding about the Globe of the Earth till they come to the Pole, where at last they lose themselves.

But in the *Plain* and *Mercator's* Charts, they are represented by straight Lines. Their Use is to shew the bearing of any two Places one from another; that is, upon what Point of the Compass any Shore or Land lies from another.

RUMBS; Here is a Table of Rumbs or Points of the Compass; shewing how many Degrees and Minutes each Point contains.

A Table



A Table of *R U M B S*.

*The Distance of the Rumbs, or Points from the Meridian.*

| <i>North</i>  | <i>South</i>  | <i>D. M.</i> | <i>South</i>   | <i>North</i>   | <i>Point.</i> |
|---------------|---------------|--------------|----------------|----------------|---------------|
|               |               | 2 49         |                |                |               |
|               |               | 5 38         |                |                |               |
|               |               | 8 26         |                |                |               |
| <i>N by E</i> | <i>S by E</i> | 11 15        | <i>S by W</i>  | <i>N by W</i>  | 1             |
|               |               | 14 4         |                |                |               |
|               |               | 16 53        |                |                |               |
|               |               | 19 41        |                |                |               |
| <i>NNE</i>    | <i>SSE</i>    | 22 30        | <i>SSW</i>     | <i>NNW</i>     | 2             |
|               |               | 25 19        |                |                |               |
|               |               | 28 8         |                |                |               |
|               |               | 30 36        |                |                |               |
| <i>NEbyN</i>  | <i>SEbyS</i>  | 33 45        | <i>SW by S</i> | <i>NW by N</i> | 3             |
|               |               | 36 34        |                |                |               |
|               |               | 39 23        |                |                |               |
|               |               | 42 11        |                |                |               |
| <i>NE</i>     | <i>SE</i>     | 45 00        | <i>SW</i>      | <i>NW</i>      | 4             |
|               |               | 41 49        |                |                |               |
|               |               | 50 37        |                |                |               |
|               |               | 53 16        |                |                |               |
| <i>NEbyE</i>  | <i>SEbyE</i>  | 56 15        | <i>SW by W</i> | <i>NW by N</i> | 5             |
|               |               | 59 4         |                |                |               |
|               |               | 61 52        |                |                |               |
|               |               | 64 41        |                |                |               |
| <i>ENE</i>    | <i>ESE</i>    | 67 30        | <i>WSW</i>     | <i>WNW</i>     | 6             |
|               |               | 70 19        |                |                |               |
|               |               | 73 7         |                |                |               |
|               |               | 75 56        |                |                |               |
| <i>EbyN</i>   | <i>EbyS</i>   | 78 45        | <i>W by S</i>  | <i>W by N</i>  | 7             |
|               |               | 81 34        |                |                |               |
|               |               | 84 22        |                |                |               |
| <i>East</i>   |               | 87 11        | <i>West</i>    |                |               |
|               |               | 90 00        |                |                |               |



**RUMB-Scale:** How the Scale of Rumbs is made, you will find under the Word *Plain-Scale*.

How to find the Rumb between two Places by Calculation, and Geometrically, Mr. Collins shews in his *Navigation*, pag. 39. Thus:

*As the Radius: Is to the Co-sine of the Middle Latitude::*

*So is the Difference of Longitude:*

*To the whole Departure from the Meridian, in the Course between the two Places proposed::*

And in the second Proportion:

*As the Radius: Is to the half Sum of the Co-sines of both Latitudes::*

Or rather for Geometrical Schemes.

*As the Diameter: Is to the Sum of the Co-sines of both Latitudes::*

*So is the Difference of Longitude: To the Departure from the Meridian, in the Course between the two Places::*

The latter Proportion of this Division, of which we make no Use, is:

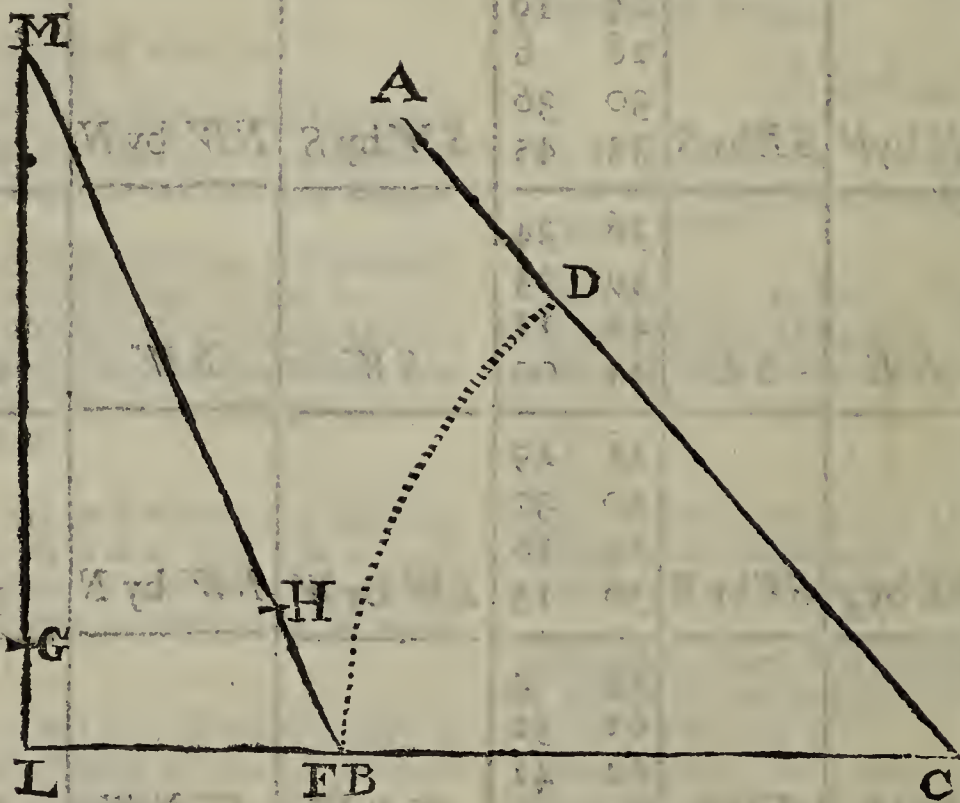
*As the Difference of Latitude:*

*Is to the aforesaid Departure from the Meridian::*

*So is the Radius: To the Tangent of the Rumb::*

An Example of the former Proportion.

Let the Rumb be required between *Cape Finistère*, Latitude 43 Degrees, Longitude 7 Degrees 20 Minutes, and *St. Nicholas Isle*, Latitude 38 Degrees, Longitude 352 Degrees, the Middle Latitude is 40 Degrees 30 Minutes, the Complement is 49 Degrees 30 Minutes, and the Difference of Longitude is 15 Degrees 20 Minutes, or 33 Centesims.



Out of the lesser equal Parts, prick down 15 Degrees 33 Centesims from *C* to *L*, and describe the Arch *B D* with 60 Degrees of the Chords, and make it equal to 49 Degrees 30 Minutes, and draw *C D* continued further to *A*, from *L* take the nearest Distance to *A C*, which is equal to *L M*, and make it one Leg of a Right-angled Triangle: Make the other Leg the Difference of Latitude 5 Degrees, which prick from the equal Parts from *L* to *F*, then the Extent *M F* measured on the said Parts, sheweth the Distance to be 13 Degrees 39 Centesims, which allowing 20 Leagues to a Degree, is almost 268 Leagues; with the Radius *C B* setting one Foot at *M*, cross the Rumb Triangle at *G* and *H*, which Extent measured on

the greater Chord is almost 22 Degrees, the Complement whereof is 68 Degrees, and so much is the Rumb from the Meridian between these two Places, which is 6 Points and about 30 Minutes more, wherefore *St. Michaels Isle* bears from *Cape Finistère* West-South-West, half a Degree more Westwardly.

If the two Places had been both in the Latitude of 40 Degrees 30 Minutes, having the same Difference of Longitude, *to wit*, 15 Degrees 20 Minutes, then had the Extent *L M* been their Distance, *to wit*, 11 Degrees 68 Centesims, at 20 Leagues to a Degree, is 233 Leagues and a half, and thus we supply the want of the Scale of Longitudes, in finding the Distance of

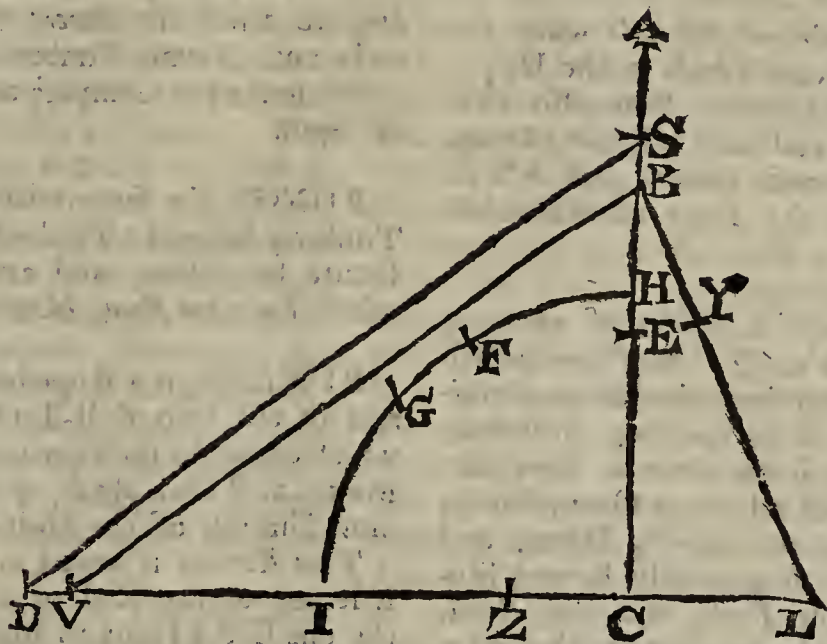


of Places that bear East and West; as those that are in the same Latitude must needs do.

*An Example of the Latter Proportion.*

Let it be required to find the true Rumb and Distance between the *Lizard* and the

*Bermudas.* Mr. Norwood in his *Sea-man's Practice*, p. 110, maketh the Latitude of the *Lizard* to be 50 Degrees, and of the *Bermudas* 32 Degrees 25 Minutes, or 32 Degrees 41 Centesims, and the Difference of Longitude between these Places to be 55 Degrees.



Draw the Lines  $AC$  and  $CD$  at Right-angles, now for want of room I use the lesser Chord, and with 60 Degrees thereof I describe the Quadrant  $HI$ , and prick the Radius from  $I$  to  $D$ , so is  $CD$  the Diameter, then count both Latitudes from  $H$  to  $F$  and  $G$ , the nearest Distance from  $F$  to  $CI$ , is the Co-sine of *Bermudas* Latitude, which prick from  $C$  to  $E$ : Again, the nearest Distance from  $G$  to  $CI$ , is the Co-sine of the *Lizard's* Latitude, which place from  $C$  to  $S$ , so is  $CS$  the Sum of both Co-sines: Draw  $DS$ , and prick down 55 Degrees, the Difference of Longitude from  $C$  to  $V$ , out of the greatest equal Parts, and draw  $VB$  parallel to  $DS$ , so is  $CB$ , the Departure from the Meridian, in the Course between both Places; then making that one Leg of a Right-angled Triangle, prick down 17 Degrees 59 Centesims, the Difference of Latitude between those Places out of the same equal Parts from  $C$  to  $L$ , and draw  $BL$ , which represents the Course and Distance truly between the *Lizard* and *Bermudas*, and the Extent  $LB$  measured on the same equal Parts, shews the Distance to be 44 Degrees 31 Centesims, which allowing twenty Leagues to a Degree, is 886 Leagues.

Then to find the Course: with 60 Degrees of the Chords, setting one Foot in *L*, with the other make a Mark at *Y* and *Z*, then the Extent *ZY*, measured on the Chords, sheweth the Rumb to be 66 Degrees 37 Minutes from the Meridian, which is almost 6 Points; and in this Example the Proportion doth not err

any thing from the Truth, according to *Mer-  
cator's Chart*, whereas if you use the former  
Proportion, by the middle Latitude, the Rumb  
would have been 67 Degrees 2 Minutes from  
the Meridian, and the Distance 902 Leagues;  
if you make  $CA$  equal to  $CV$ , then a Line  
joining  $LA$  should be the Course and Distance  
according to the same Longitudes and Latitudes  
laid down on the *Plain Chart*, and thereby the  
Course should be 72 Degrees 17 Minutes from  
the Meridian, and the Distance 1155 Leagues;  
however, when two Places are laid down true  
at first in their Rumb, Distance and Latitudes on  
the *Plain Chart*, if you sail home, in, or near  
the same Rumb, the *Plain Chart* will very well  
serve to keep the Reckoning upon, and to sail  
by in the greatest Voyage.

What the Nature of this Rumb Line is on the Globe, and how to *delineate* it there, and in a Chart, Mr. *Collins* shews in the same Book, page 55, and 64.

RUMINANT *Animals*, are such as chew the Cud; and these are Quadrupeds, Hairry, and Viviparous; and, in general, Mr. Ray observes of them, that some have *hollow and perpetual Horns*; others *deciduous* ones, or such as are shed every Year; and all the *Horned Ruminant Animals* have four Stomachs. 1. The *Κοιλία Μεγάλη* of *Aristotle*; the *Venter Magnus*, or what we call the *Paunch* or *Inward*. This receives the Meat slightly chewed, retains it a while, and then delivers it back again into the Mouth, which is what we call the *Cud*, to be re-chewed and render'd



der'd more fit to make Chyle. 2. The *Κερέφαλον*; or *Reticulum*, which we call the *Honey-Comb*; from its Internal Coat, being divided so into Cells like Honey-Combs. 3. The *Ψαλόν*, which Mr. Ray thinks hath been wrong Translated, *Omasus*; and therefore he would have it called the *Echinus*: This is so difficult to clear, that our People throw it away, and call it the *Manifold*. 4. The *Ψύμας* of *Aristotle*, by *Gaza* called the *Abomasus*. The Stomach in Calves is that which contains the acid Ferment, which we call the *Runnet*, and is used to coagulate Milk into Cheefe.

All all Horned Ruminant Animals want the *Dentes Primores*, or broad Teeth in the Upper Jaw. These Kind of Animals have also that Kind of Fat which we call *Suet*; *Sebum*, *Στεας*, which is much harder and firmer, and less liquifiable in them, than the *Adeps* of other Animals.

RUMINATION, is the Action of chewing the Cud in some Animals. *J. Con. Peyerus* hath written a Treatise, *De Ruminantibus & de Ruminatione*, printed at *Basl* in *Quarto*, in which he takes notice, That some Animals do really and truly chew the Cud; such as Oxen, Sheep, Deer, Goats of all Kinds, Camels, Hares, and Squirrels; which therefore generally have 3 Stomachs, the *Paunch*, the *Feck*, and the *Read*. But those that seem only to imitate that Motion, he calls *Ruminantia Spuria*; such as the Mole, Cricket, Bee, Beetle, Crab, Lobster, Mullet, and several Birds. And these he affirms to have all of them their Stomachs composed of Muscular Fibres, by means of which, they do as it were grind and work their Meat up and down something like *Ruminating Creatures*. He defines

*Rumination to be a Natural Motion of the Stomach, Mouth, and other Parts, which relieve one another in this Action; by which means the Meat eaten hastily at first, is conveyed back to the Mouth again, there chewed, and then swallowed down a second time, to the great Advantage of the Animal.*

RUN of a Ship, is so much of her Hull as is always under Water, growing thinner and lanker by Degrees from the *Floor-Timbers* to the Stern-Post. This is also called her *Way* afterward on; and they say a Ship hath a good Run, when 'tis long, and that the Water passes cleverly to her Rudder, her *Tuck* not lying too low, which is of great Importance to her Sailing; for if the Water don't come strongly to her Rudder, by reason of her being built too broad below, she can never steer well; and a Ship that can't steer well, cannot keep a good Wind, and will have no fresh Way through the Sea, but will be still falling to Lee-ward, and therefore can

never be a good Sailor. Nevertheless a Ship with a large and good Run, will lose much Stowage, because she is narrow below.

RUNCINUS, and *Runcilus* in *Doomsday-Book* is used for a Load-Horse: Sumpter-Horse, or Cart-Horse: This Kind of Horse, *Chaucer*, in his *Seaman's Tale*, calls a *Rowney*.

RUNDLES, or *Roundels*, the same as Balls or Bullets, which see. 'Tis a Word used in Heraldry.

RUNG-Heads, which are made a little Bending to direct the Sweep or Mould of the *Put-locks* and Naval Timbers; for here the Lines which make the Compaſs and Bearing of a Ship, do begin.

RUNGS, the same with the Floor or Ground-Timbers, being the Timbers in a Ship which constitute her Floor, and are bolted to the Keel, whose Ends are *Rung-Heads*.

RUNNER, is a Rope belonging to the *Garnet*, and to the two Bolt-Tackles, viz. That before, which comes in the aftermost Shrouds of the Fore-Mast; and that abaft, which comes in the foremost Shrouds of the Main-Mast.

This *Runner* is reeved in a single Block, which is seized to the End of a Pendant, and has at the one End a Hook to hitch into any thing, and at the other End a double Block, into which is reeved the Fall of the Tackle or the *Garnet*, by which means it doth purchase more than the Tackle or *Garnet* can do alone. The Word is, *Overhaul the Runner*; that is, bring down that End which has the Hook to it, that it may be hitched into the Sling, &c.

RURAL-Deans. There were formerly in the Church, *Arch-Presbyters*, as well as *Arch-Deacons*; and they were called *Rural-Deans*. Our Diocesses are still divided into Deanries, and he who under the Bishop and Arch-Deacon, had the peculiar Care and Inspection of the Clergy and Laity of such a District as is now called a Deanry, was the *Rural-Dean*. He had Power to visit and to hear Causes, they had a Seal of their Office, but were removeable at pleasure, but jointly by the Bishop and Arch-Deacon. The rest of the Clergy within the Deanry were called the *Rural-Dean's Chapter*.



RUSTRE, [in Heraldry,] is exactly the same square Figure as the Mascle, only the Rustre is pierced round, whereas the Mascle is pierced square, as in the Figure.





**S**ABLE; the Herald's Word for a Black Colour in the Arms of Gentlemen; but in those of the Nobility, they call it *Diamond*, and in the Coats of Sovereign Princes, 'tis called *Saturn*.

'Tis expressed in Engraving by Strokes drawn perpendicularly a-

cross each other.

**SAC**, or *Sacha*, or as some write it *Saccha* and *Saucha* (according to *Minshew*) was anciently a Royalty or Privilege touching Plea, or Correction of Trespasses of Men within a Mannor: The Saxon Word, *Sac*, signifying as much as *Causa* in Latin (whence our *English Sake*; for whose sake, &c. but in the Laws of Edward the Confessor, it is said, *Sacha est quod si quilibet aliquem nominatim, de aliquo calumniatus fuerit & ille negaverit, forisfactura Probationis vel Negationis (si e venerit) sua erit*. From some old Manuscripts, it appears also that *Saka* was a Liberty of Holding Pleas, and Imposing Mulcts and Forfeitures on Transgressors in the Court of any Lordship or Mannor; though *Rastal* and others will have *Sac* to signify the Forfeiture itself.

**SACCADE**, in the *Manage*, a violent Check given to the Horse by his Rider, by drawing both the Reins very suddenly, used when a Horse bears too heavy on the Hand.

**SACCHARUM Saturni**. See Salt of Saturn.

**SACCULI Adiposi**, in Anatomy, little Cells or Vehicles in the *Membrana Adiposa*, in which the Fat of the Body is contained.

**SACCULI Medicinales**, are when several Simples, according to the Nature of the Disease, are compounded and beaten together, and tied up in a little Bag, to be applied to the Part affected. This Bag is to be sewed or quilted down in several Places, that the Ingredients run not altogether in a Lump. *Blanchard*.

**SACCULUS Chyliferus**, or *Roriferus*, is what we usually call the *Receptaculum Chyli*; and sometimes *Receptaculum Pecquetianum*, from *Pecquet*, who first found out both it and the *Ductus Thoracicus* (whose beginning it is) in the Year 1651. I mean he was the first that assigned the true Use unto them, but both were observed in Horses by *Bartholomæus Eustacius*, above 160 Years ago, as appears in a Book he writ, 1564, pag. 301, of the *Vena sine pari*, wherein he has these Words, (as cited by Dr. *Wharton*.)

From this notable left Trunk of the Throat (viz. the Subclavian Vein) there springs a great Branch, which besides that it has a Semi-circular Door (or Valve) in its Origin, is moreover white, and full of watry Humour; and not far from its rise it is divided into two, that after a little space, unite again into one, which sending forth no Branches, descends by the left side of the *Vertebræ*; and having passed through the *Midriff*, runs down the middle of the *Loins*: Where becoming larger, and folding about the great Artery, it has an obscure ending, which I have not as yet well discovered.

Here we have a clear Description of them, only that it is the Beginning which he takes for the End:

And contrarily, it is called the *common Receptacle*, because it receives both the *Chyle* and *Lympha* promiscuously, tho' some call it the Receptacle of the *Chyle*, in particular, but without reason; for it might as well be called, *Receptaculum Lymphæ*, as *Chyli*; for that the *Lympha* passes not only with the *Chyle*, but after this is all distributed, the *Lympha* still continues to glide into it, and to ascend by the *Ductus Chyliferus Thoracicus*, which might as well be called *Lymphaticus* for the same reason.

It is seated under the Celiac Artery, and Emulgent Veins, about the middle Distance between the Kidneys and *Capfulæ atrabiliaræ*, upon the *Vertebræ* of the *Loins*, but for the most part, rather toward the left Side.

*Pecquet* and *Casp. Bartholin* say, 'Tis seated betwixt the Tendon (or Appendices) of the *Diaphragma*; by the Motion whereof, it is pressed and milked, as it were, and its Contents propelled. It is of a membranous, but thicker Substance in Men than in Brutes, but not so capacious, seldom being so large as to admit one's Finger's end. Out of it there springs a Duct that presently ascends up into the *Thorax* (behind the descending Trunk of the *Arteria magna*) where it begins to be called *Ductus Thoracicus*; but, according to *Sylvius*, it might more fitly be called *Spinalis*, seeing it runs along the inside of the *Spina Dorsæ*.

This Duct having pass'd the *Abdomen* and the *Midriff*, marches farther upward under the great Artery, 'till about the fifth or sixth *Vertebra* of the *Thorax*, where it turns a little aside from under it to the left Hand; and so underneath the *Intercostal Arteries* and *Veins*, and the Gland *Thymus*; it ascends to the left Subclavian Vein, into whose lower Side it opens, just there where the left Jugular Veins enter into it on the upper Side; so that their Mouths face one another. But it opens not into this Vein with any large Orifice, but by six or seven little ones, which are all cover'd in the Cavity of the *Subclavia* with one broad Valve, looking towards the Cava from the Shoulder, whereby there is granted to the *Chyle* and *Lympha* a free Passage out of the *Ductus Chyliferus* into the *Subclavia*, but their return (or of Blood with them) out of the Vein into the Duct, is prevented.

This Duct ending thus in the Subclavian Vein, the *Chyle* that it conveys into it, passes with the Blood (returning by the Cava) into the right Ventricle of the Heart, where we will leave it to supply the Defect of the depauperated Blood; having only observed, that this Duct has many Semilunar Valves that hinder the ascending *Chyle* and *Lympha* from gliding back again; which Valves are manifest by this, that the *Chyle* contained in the Duct may easily by the Finger be pressed upwards, but by no means downwards; or if one make a Hole in it, the Liquor tending from beneath upwards, will flow out at it; but that which is above it, is so stopt by the Valves, that it cannot be made to descend by it.

**SACCULUS Cordis**. See *Pericardium*.

**SACCULUS Lacrymalis**, in Anatomy, a small membranous Bag, into which the *Puncta Lacrymalia* of the Eye open; and which itself is the Entrance of a Canal, by which the Liquor is discharged into



into the Cavity of the Nose that has been separated in the *Glandula Lachrymalis*.

SACCUS, is with some Writers the Gut called *Rectum*.

SACCUS *cum Brochia*, was anciently a Service or Tenure of finding a *Sack* and *Broach* for the King for the use of his Army. *Bracton, lib. 2. Tract. 1. c. 6.*

SACER *Ignis*. See *Herpes Exedens*.

SACER *Morbus*. See *Epilepsia*.

SACER (*Musculus*) which may be also called *Transversalis Lumborum*. It lies under the Tendinous part of the *Longissimus Dorsi*; it ariseth fleshy not only from the *Os Sacrum*, but also from all the transverse Processes of all the *Vertebrae* of the Loins, and is inserted to their Superior Spines. We have sometimes observed (saith Mr. *Cowper*) a *Spinalis Lumborum*, like the *Spinalis Colli*, which arising from the Superior Spines of the *Os Sacrum*, and marching with direct fleshy Fibres, is so inserted to the Superior Spines of the *Vertebrae* of the Loins: The *Transversalis Lumborum* lying under it, helps to move the whole Spine, or *Vertebrae* of the Neck, Back and Loins, obliquely backwards, as in looking behind us, &c.

SACER. See *Saker*.

SACKS of *Earth*, used in Fortification, are made of coarse Cloth, the largest of them being about a Cubick Foot wide, and the lesser somewhat more than half a Foot. They are serviceable upon several Occasions; more especially for making Retrenchments in haste, to place on Parapets, or the Head of the Breaches, &c. or to repair them when beaten down. They are of good use also when the Ground is rocky, and affords not Earth to carry on Approaches, because they can be easily brought on and carried off: The same Bags on occasion, are used to carry Powder in; of which they hold out about 50 Pound a-piece.

SACK of *Wool*, is a determinate Quantity, containing just 26 Stone, and every Stone is fourteen Pounds, by 14 E. 3. Stat. 1. c. 2. But in *Scotland* a Sack is 24 Stone, and each Stone contains 16 Pounds.

SACRAMENTO *recipiendo, quod vidua Regis se non maritabit sine licentia Regis*, is a Writ or Commission to one, for taking of an Oath of the King's Widow, that she may not marry without the King's Licence.

SACRE. See *Saker*.

SACRILEGIUM, Sacrilege, or an Alienation to Laymen, and to profane or common Purposes, of what was given to religious Persons, and to pious Uses. Our honest Fore-fathers were very tender of incurring the Guilt and Scandal of this Crime. And therefore when the Order of the Knights-Templers was dissolved, their Lands, &c. were all given to the Knights Hospitallers of *Jerusalem*, for this sacred Reason: *Ne in plus usus erogata contra donatorum voluntatem in alios usus distraherentur*.

SACROLUMBALIS, is a Muscle of the *Thorax*, which with the *Dorsi Longissimus*, have their Origination in common: Externally they are Tendinous; as they spring from the Posterior Part of the Spine of the *Os Illium*, and Superior Spine of the *Sacrum*, and all the Spines of the *Vertebrae* of the Loins: Internally it arises fleshy, not only from those Parts, but from the Transverse Processes of the last named *Vertebrae*; whence with direct Fibres ascending before it marches over the last Rib, it's di-

vided into two fleshy Bodies; the outermost of which is called *Sacrolumbus*, whose Fibres ascend directly, and make so many thin Tendons as there are Ribs to whom they are inserted, which are joined with so many Accessory Muscles, arising from each Rib, and united with them, before their Insertions, as they pass over the Superior: And this Order or multiformed Disposition of it, is continued the whole Length of the *Thorax*, to the third, fourth, fifth and sixth *Vertebra* of the Neck; which Superior Part is by *Diemerbroeck* made a distinct Muscle, and called *Cervicalis descendens*.

SACRUM *Os*: The *Os Sacrum* is the broadest of all the Bones of the Back, and doth sustain all the other *Vertebrae*: On the Inside it is smooth and hollow, on the Outside convex and uneven, being of something a triangular Shape. In its upper Part on each Side it is knit firmly to the *Ossa Ilii*, by an inverting Cartilage. It consists of five or six Bones, plainly distinguishable in Infants, but more obscurely in grown Persons. These Bones have the Resemblance of (and are usually called) *Vertebrae*; for each of them have a Body and Processes, and a large Hole to receive the *Spinalis Medulla*. The Bodies of these differ from those of the other *Vertebrae* in this respect; that whereas in those the lower Part is always bigger, in these it is the less; by which means the uppermost is the biggest, and the lowest the least. Their smaller Holes which serve for the Ingress and Egress of the Vessels, differ also from those of the other, in that they are not in their Sides, but before and behind; of which those before are much the larger. As for their Processes, the Oblique can hardly be discerned, except in the first. The Transverse are pretty long, but so united, that all seem but one. The hinder, or Spines, are like those of the Loins, but less, and still the lower the lesser; insomuch that the lowest hath no Process, but only a round Protuberance.

SAFE *Conduct*, is a Security given by the Sovereign under the Great Seal of the Kingdom to any Person for his quiet coming into, or passing out of the Realm.

SAFE *Pledge*, is a Security given for a Man's Appearance at a Day assigned.

SAFE *Guard*, in *Sea Language*, is a Rope that saves and secures any thing, as the *Safe-guard of the Helm* is a Rope which goes through the Helm, and is fastened to the Buttocks of the Ship. Also that Rope by which Persons walk securely over the Bolt-sprit is called a *Safe-guard*.

SAFFRON of *Gold*. See *Aurum Fulminans*.

SAFFRON of *Steel*, or *Mars*. See *Crocus Martis*.

SAGIBARO, or perhaps *Sachbaro*, anciently signified the same as *Justiciarius*, from *Sac causa*: So that *Sac-baro* is as much as the *Cause-bearer*, or the Man that hears Causes.

SAGITTA, a *Constellation* in the Northern Hemisphere, consisting of eight Stars.

SAGITTA, in Botany, signifies the upper Part of any small Twig, Cyon, or Graft of a Tree.

SAGITTA, in Mathematicks, is the same as the *Versed Sine* of any Ark, and is so called by some Writers, because 'tis like a Dart or Arrow standing on the Chord of the Ark. See *Versed Sine*.

SAGITTALIS *Sutura*, or *Veruculata*, is that Suture of the Scull, which begins at the *Coronal Suture*, and ends in the *Lambdoidal Suture*.

SAGITTARIUS, is the Ninth, in the Order of the twelve Signs of the *Zodiack*.



*To SAIGNER a Moat*, is to drain the Water by subterraneous Conveyances, to the end that Hurdles laden with Earth, or a Bridge of Bulrushes, may be afterwards laid upon the Mud that remains, and the Passage thereby consolidated.

**SAIL**: Every Yard in a Ship hath its proper Sail to it, and takes its Name from the Yard: As the *Main-sail*, is that which belongs to the *Main-yard*: The *Fore-top Sail*, is that which belongs to the *Fore-top-mast Yard*, &c. *Head Sails*, are such as belong to the *Fore-mast* and *Bolt-sprit*: These are used to keep a Ship from the Wind, and to flat her. *After Sails*, as the *Main-mast* and *Mizen Sails* do keep a Ship to the Wind.

Few Ships can steer on a quarter Wind with one Sail, but require a *Head Sail* and an *After Sail* both, one to countermand the other: Tho' some Ships can steer with their *Main-top Sail* only.

The *Mizen Sail* is cut by the Leech twice as deep as the Mast is long, from the Hounds to the Deck: And the *Sprit Sail* is  $\frac{3}{4}$  of the Depth of the *Fore Sail*.

The *Sail* being of so great and universal Use, by its Application to the Motion of a Ship, and of a Windmill, it is necessary to add an Explanation of its Nature and Properties, the moving Principle of this Power being that Motion of the Air which we call Wind, and not the Strength of an animal Creature, as of the Powers above-described, it will be proper to spend a few Words in the Consideration of this new Principle.

Wind is a Stream or Current of the Air, tending sometimes one Way, sometimes another, in all manner of Directions: The Force of it is sometimes prodigious, as every one knows; and from that Height of Violence it descends through all Degrees of Strength and Weakness to a perfect Calm. Its Velocity in furious Tempests is found to be about 60 Miles in an Hour; and sometimes its Motion is so slow, that one may out-walk it. Now between these two Extremes there are several intermediate Degrees of Velocity, which serve very conveniently for a Principle of Motion, when their Force is applied and directed to a certain End by proper Contrivances. This is done by means of the Sail; which is in Practice a large Sheet of Canvas, or such like Matter; and in Speculation, a Mathematical Superficies.

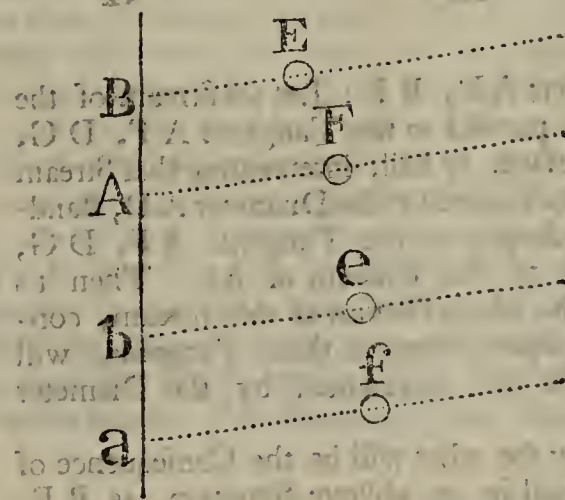
The Manner of the Operation of the Wind upon the Sail, may be, I think, best conceived by a Supposition like the following: Let us imagine a Ship in the Middle of the Sea, and the Air to be perfectly calm; let there be supposed afterwards a Stream of Air to come on the sudden from the North, for Example, or any other Point of the Compass: Let the Motion of this Stream of Air be of an ordinary Swiftmess, as for Example, ten Miles an Hour; this Current of Air will move for a great Way along the Surface of the Sea, without any Interruption; its several Particles describing Lines parallel thereto. At last, when it is arrived at the Place where the Ship is, a Portion of this Stream of Air, whose Area and Figure is equal and similar to that of the Sail, will be intercepted by the Sail in its Course. This intercepted Portion will endeavour to drive the Sail, and consequently the Ship before it with a Velocity equal to its own: And indeed were it possible for the Ship to float upon the Sea, without drawing Water, it actually would do so. But since by the Laws of Hydrostatics, and the Structure of the Vessel, the Keel

must be immers'd under Water, it comes to pass, that the Keel, in dividing the Water for its Passage, meets with a good deal of Resistance; and that Resistance, though it is not sufficient, as we find by Experience, to stop the Motion of the Ship, must to be sure, in some measure, retard it; so that by the Action of the Wind upon the Sails, the Ship is carried along; but by reason of the Resistance the Water makes to the Keel, not so fast as the Wind itself moves. After this manner, we may form an Idea of the Operation of the Wind upon a Ship at Sea.

As in the other Powers, so in this, many Truths relating to it may be discovered grossly, and in general, from ordinary Observation; but our present Design being to consider it more nicely, and mathematically, we shall now proceed to lay down some Axioms, as Premises, from whence to draw such Conclusions, as may shew the Properties of this mechanical Power.

1. In the Current of the Air, which we call Wind, the Particles of the Air will naturally be born along in right Lines parallel to each other. It is true, we sometimes see it otherwise; as when the Atoms of Dust are dancing about in the Sun, they move in irregular Figures, as the Particles of Air are carried about; but that proceeds always from some Obstacle, which make the Stream of Air recur into itself; whereas, if that Obstacle was removed, those little Motes would be seen to proceed in right Lines parallel to each other, or nearly; the Irregularity of the Air's Motion it self keeping them from being exactly parallel: However, in our Reasonings about them, we always suppose them parallel, the Difference being of little or no Consequence.

2. These Particles of Air being alike in the Direction of their Motion, must be supposed alike also in other respects: so that what is found true of any one Part or Particle, may also be applied to the rest.



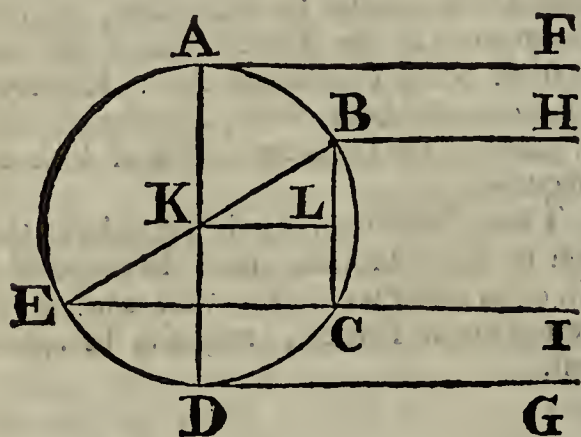
As if B A b a represent a Superficies, which is a Sail mathematically consider'd, and a Particle of Air at E moving in the Direction E B, impel the Point B of the Superficies with a given Force; then by this second Axiom the Particles F, e, and f, moving in Lines parallel to E B, will impel the Superficies in the Points A, b, and a in the same manner, and with the same effect in all respects as the Particle E did in B. So again, if in the Space between E B and F A, we suppose a great number of Particles moving in the Direction E B towards the Part B A of the Superficies, and impelling it, each of those Particles will impel the Superficies successively in the same manner. And again,



again, the Effect of the Aggregate or Sum of all those Impulses will be the same as of another Set of Particles moving in the same Direction between  $e b$  and  $f a$ , and impelling an equal Part of the same Superficies  $b a$ .

Since therefore all the Particles of Air moving in the same Direction, have like Effects, it follows, that a Stream of Air or Wind operates upon a Superficies, or Sail, in Proportion to the Sine of the Angle of its Incidence. For by the second Axiom the Effect of the whole Stream is like to that of any one Particle. And by what I shew'd under the inclined Plane, the Effect of any one Particle will be as the Sine of the Angle of Incidence. Therefore the Effect of all the Particles, that is, of the whole Stream of the Air, will be also as the Sine of the Angle of Incidence.

But this is true upon this Supposition only; the number of airy Particles acting upon the Sail, or Superficies, is the same at all Degrees of Inclination. If this Supposition be not true, there will arise an Alteration of that Proportion: For if in one Position 1000 Particles impel the Sail in a certain Time, and in another Position only 750, 'tis plain, that all other things being alike, the Action in one Case must be as 1000, and in the other as 750 only. To find therefore the Difference of the Impulse occasioned by the different Situation of the Sail, let there be described in the Fig. the Circle ABCDE. Draw the



two Diameters AD, BE: Let the Stream of the Air proceed parallel to the Tangents AF, DG, and let a Surface, or Sail, intercepting that Stream of Air, be represented by the Diameter AD, standing at right Angles to the Tangents AF, DG, and therefore to the Current of Air. Then 'tis plain, that the whole Portion of this Stream, contain'd in the Space between those Tangents, will fall upon the Sail represented by the Diameter AD.

Let us now see what will be the Consequence of turning the Sail in an oblique Situation, as BE. Draw BH, EI parallel to AF, DG: Then it plainly appears, that the Particles of Air contained in the Space between BH and AF on one Side, and in the Space between CI and DG on the other, pass beside the Sail BE when it is in this Position, not touching it at all. Draw BC parallel to AD, and then the Portion of the Stream acting upon the Sail BE, will be as BC, and the Portion of the same Stream acting upon the Sail AD, will be as AD it self. Draw KL from the Centre K, parallel to IE: Then is the Angle BKL, equal to the Angle of Incidence IEB: Therefore BL is the Sine of the Angle of Incidence: But the two different Portions of the airy Streams acting upon

AD and BE, were shewn to be as AD and BC; therefore they are also as the Halves of those Lines; that is, as AK the Radius, and BL the Sine of the Angle of Incidence: That is universally, the Number of Particles falling upon the Sail, will be as the Sine of the Angle of Incidence.

Now this Ratio compounded with the former, makes the entire Effect of the Stream of Air upon a Sail, to be as the Square of the Sine of the Angle of Incidence.

But this is still upon a Supposition, that the Velocity with which the Particles of the Air move, is always the same: But that is not always the Case; now 'tis plain, that the Impulse of a Stream of Air, moving with a Velocity, that is, as 2 will be twice as great as that of a Stream moving with a Velocity, that is as 1: Therefore the Impulse of the Wind upon a Sail, will be as the Square of the Sine of the Angle of Incidence, and as its Velocity also.

But this Proportion supposes the Number of Particles of Air impelling the Sail, to be the same at all Degrees of Velocity, which is not true; for the greater the Velocity of the Motion of the Air is, the quicker is the Succession of the airy Particles impelling the Sail; therefore the Number of those Particles is as the Velocity.

Therefore, since the Effect of the Wind is as the Velocity of each Particle, and as the Number of Particles, which is also as the Velocity of each Particle, it follows, by compounding these two Proportions together, that the Effect of the Wind is as the Square of its Velocity, and as the Square of the Sine of the Angle of Incidence.

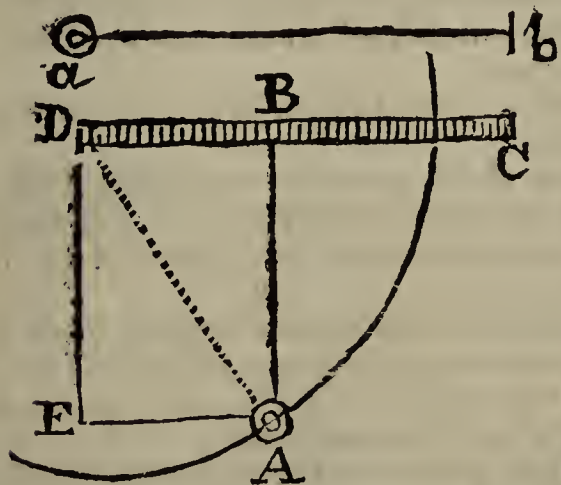
The next thing to be consider'd is, the Direction of the Operation of the Wind, or the Line or Lines of Directions, in which a Stream of Air impinging upon a Superficies, endeavours to impel it. Now if we suppose the Wind to move in a Direction perpendicular to the Superficies, it is evident, that it will impel it along the same right Line in which it self moves. As if a Wind moving in the Direction AB impel a Superficies, as CD at right Angles, as in Fig. 1, 'tis plain that it must oblige it to move along, and parallel to the Line BE. But if we suppose the Line AB, or the Direction of the Wind to be inclined to the Superficies, 'tis not so clear, which Way the Superficies will be impelled. To determine that, let there be drawn the Line FB perpendicular to the Surface, and the Line AF parallel thereto; then will the Action of the Wind upon the Surface be resolved into two, one parallel to the Surface, and therefore of no Effect, and the other perpendicular thereto, parallel to FB. Now this last Force tends to impel it along BE, with a Force that is to the Force of the same Wind at right Angles, as FB to AB: Therefore the Superficies will move in the same Line of Direction, when impelled at any Angle, and the Difference will consist only in the Velocity of its Motion.

From what has been said, we may deduce these Conclusions relating to this Power. 1. That since the Effect of the Wind is *ceteris paribus*, as the Square of the Sine of the Angle of Incidence, it will be necessary, in order to make its Effect as great as possible, to make that Angle as great as possible, that is, a right one. 2. That nevertheless, this is to be understood only of a single Sail; but if, as in large Vessels, we make use of more than one, the Case will be much alter'd: For in the 2d Figure, let ABCD, HIKL, represent two parallel Sails,



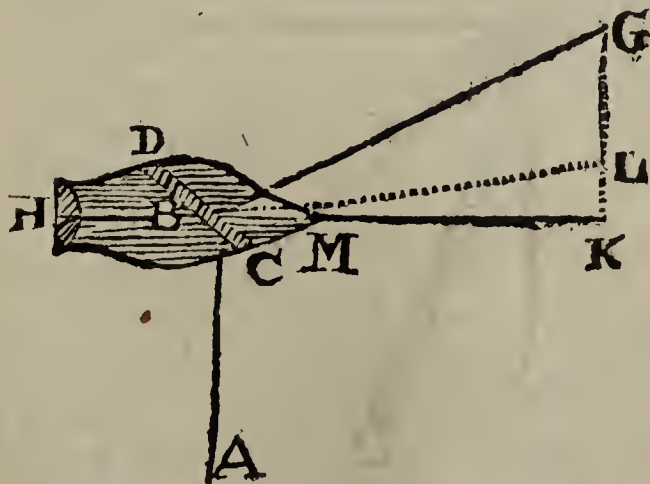
Sails, which we may suppose applied like those in a Ship; and imagine the Wind to move in the Direction  $E F$ , at right Angles to the Superficies  $A B C D$ . Now in that Case, by what was said before, it will undoubtedly have a greater Effect upon that Sail, than if it mov'd in the Direction  $C G$  at an Angle of  $60^\circ$ , by how much the Square of Radius exceeds the Square of the Sine of  $60^\circ$ . But then the hindmost Sail will be of little or no use, by reason that the other standing directly between it and the Wind, will keep off the Wind from acting upon it. But if the Wind moves at an Angle of  $60^\circ$ , to both the Superficies, it will act equally upon them both, with an Effect, that is, as the Square of the Sine of  $60^\circ$ . Therefore their several Forces being united, will exceed the Force of a Wind applied at right Angles, as much as twice the Square of the Sine of  $60^\circ$  exceeds the Square of the Radius. And if we suppose three Sails behind each other, as is usual, the Advantage of such a tide Wind appears still greater; being as three times the Square of the Sine of  $60^\circ$  to the Square of Radius. 3. The Effects of the Sail being in Proportion *cæteris paribus* to the Number of Particles in Proportion to the Bigness of the Sail, or the Area of the Superficies, it follows, that the Effect of the Sail, *cæteris paribus*, will be as its Area; so that in order to make its Effects as great as possible, its Area must be as great as possible.

**SAILS and Sailing of a Ship.** In order to compute the Force of the Water against a Ship's Rudder, Stem or Side; or the Force of the Wind against her Sails, a late Author, whose Book is printed at *Paris* by the French King's express Command, and called, *The Theory of the Handling or Working of Ships at Sea*, and lately *Englised*, proceeds on this Foundation; 1. He considers all Fluid Bodies, as the *Air* or *Water*, &c. as being composed of little Bodies or Particles, which when they act upon, or move against any Surface, do all move parallel one to another, or strike against the Surface after the same manner. 2. He considers that the Motion of any Body, with regard to a Surface on which it is to strike, must be after one of these three ways, either *Perpendicular*, *Parallel*, or *Oblique*. In the first Case, let the Line



$DC$ , in *Fig. 1*, represent a plain Surface, and let the Line  $AB$  be perpendicular to it, describing the direct Impulse of the Body  $A$  upon it with all its Force, and this Force may be called *Absolute*, and may be expressed by the Line  $AB$ , which the moving Body  $A$  describes: And this Absolute Force will be *greater* or *less*, according as the Body  $A$  moves *swifter* or *slower*. (3.) If the Motion of the Body  $a$  be parallel to the Surface  $DC$ , then

'tis plain the Line of Motion  $ab$  will not affect the Surface at all, because it is no way opposed to it; nor can the moving Body strike upon it, or touch it. (4.) If the Line of Motion  $AD$  be Oblique to the Surface  $DC$ , so that the Angle of Incidence be  $ADC$ , then the Motion of the Body in the Line  $AD$ , may be resolved into two Forces, *viz.* into  $AE$ , or  $DB$ , and into  $AB$ , (*See Composition of Motion.*) But the Direction, or Line of Motion  $AE$ , being parallel to the Surface  $DC$ , cannot affect it at all; so that the whole Motion of the Body  $A$  in that Oblique manner of striking on the Surface, will be expounded by the perpendicular Line  $AB$ . And if  $DA$  be made the Radius of a Circle, whose Centre is at  $D$ ,  $BA$  will be the Sine of the Angle of Incidence  $ADC$ , and consequently, you may conclude that the Force of a Particle of *Air* or *Water*, as  $A$ , striking against the Surface  $DC$ , which may represent either a Sail; or the Rudder of a Ship, in the oblique Direction  $AD$ , will be to the perpendicular Force there, as  $BA$  is to  $DA$ : that is, as the Sine of the Angle of Incidence is to Radius. And since what is thus true of one Particle singly considered, will be true of all the Particles of any Fluid Body Collectively; it will follow, that the Force of the *Air*, or *Water* falling perpendicularly upon a Sail or the Rudder, to the Force of the same in any oblique Impingency, will be as the Square of the Radius, to the Square of the Sine of the Angle of Incidence; and consequently, that all oblique Forces of the Wind against the Sails, or of the Water against the Rudder, will be to one another as the Squares of the Sines of the Angles of Incidence. Here is no regard had to the different Degrees of Velocity, with which the Wind or Water may impinge against the Sail or Rudder; but only of the Position of the Surface so struck, with regard to the impinging Force: But when that Matter is consider'd, it will be found that the different Forces, then will be as the Squares of the Velocities of the moving *Air* or *Water*: that is, that a Wind that blows thrice as strong; or moves thrice as swift as another, will have nine times the Force upon the Sail; and it being also, saith he, indifferent, whether you consider the Motion of a Solid in a Fluid, whose Particles are at rest, or of those Particles moving all parallel against a Solid that is at rest, the reciprocal Impressions being always the same: So that if a Solid be moved with different Velocities in the same fluid Matter (as suppose Water) the different Resistances which it will receive from that Water, will be in the same Proportion as the Squares of the Velocities of that Body.



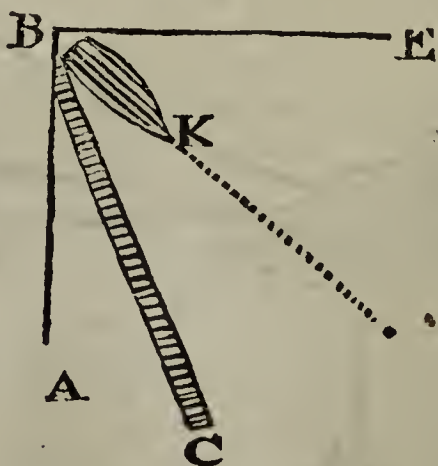
Let  $HM$  represent a Ship,  $CD$  the Position of the Sail,  $AB$  the Course of the Wind blowing towards



wards B. Draw B G perpendicular to the Sail D C, and G K perpendicular to the Line of the Keel produced H M K.

By what he hath said above, the Sail C D will be driven by the Wind A B, according to the Direction of the Line B G: So that if she could divide the Water every way with the same Facility, as she doth with her Head, the Ship would go directly to the Point G, along the Line B G. And if H K represent her direct Course, she would have got forward the Length B K, and sideways she would have gone the Quantity G K. But as her Length is much greater than her Breadth, so she will divide the Water, or make her Way in it much more difficultly with her *Side*, than with her *Head* or *Stern*; on which account, she will not run sideways so far as K G, but fall short of it in Proportion to the said Difficulty of dividing the Water with her Side: That is, if the Resistance she finds in passing thro' the Water sideways, be to that of passing lengthways, suppose as 10 to 1, then will not the Ship get sideways above a tenth Part of the Line G K. Wherefore if K G can be found to G L, in the Ratio of the Resistance of the Side to that of the *Stem*, and the Line B L be drawn, the Ship will go to the Point L, along the Line B L, in the same time as it would have gone to G, if it could have divided the Water every way equally. This Part K L is called the *Drift*, or *Lee-way* of a Ship, and the Angle K B L is her Degrees of *Lee-way*; as the Angle A B K expresses how near the Wind she lies. [Now from hence it follows, saith our Author, That if we could but find the Ratio between these two Resistances of a Ship's dividing the Water sideways and lengthways, we might determine the *Line of a Ship's true Way*.] But as this is very difficult to be done, from the Knowledge of a Ship's Figure and Proportions, so he gives another Method, whereby, he saith, it may be effected, as you may find in *Art. 2. of Chap. 2.*

After this he undertakes to demonstrate in *Art. 3. of Chap. 4.* That the best Position or Situation of a Ship, so that she may make the best *Lee-way*, but go to Windward as much as is possible, is this: Let the Sail have what Situation it will *the Ship must always be in a Line bisecting the Complement of the Winds Angle of Incidence upon the Sail.* That is, let the Sail be in the Position B C, the Wind blowing from A to B, and consequently the Angle of the Winds Incidence on the Sail A B C, therefore its Complement will be C B E; then must the Ship be put into the Position B K, or more in the Line B K, bisecting the Angle C B E.



And that the Angle which the Sail ought to make with the Wind or the Angle A B C, ought to be

but of 24 Degrees, that being the most advantageous Situation to go to Windward the most that is possible; and in order to bring this to bear in Practice, he directs to put Marks to the *Sheets*, *Braces* and *Bowlines* of the lower Sails, to know when they are in their best Situation; and then, even in the Night, when the Marks of a *Brace*, or of a *Sheet* shall come to the Cleat, one may be pretty well assured that the Sail *Trims* well.

SAILING. See *Plain* and *Mercator's Sailing*.

SAKER, a sort of Cannon, is either *Extraordinary*, *Ordinary*, or *least Size*.

SAKER *Extraordinary*, is 4 Inches Diameter at the Bore, 1800 Pound Weight, 10 Foot long, its Load 5 Pounds, Shot 3 Inches  $\frac{1}{4}$  Diameter, and something more than 7 Pound  $\frac{1}{4}$  Weight; its level Range is 163 Paces.

SAKER *Ordinary*, is a Size lesser, 3 Inches and  $\frac{1}{2}$  Bore, 9 Foot long, 1500 Weight, its Charge 4 Pounds of Powder, Bullet's Diameter 3 Inches  $\frac{1}{2}$ , Weight 6 Pounds, level Range 160 Paces.

SAKER, *the least Size*, is 3 Inches  $\frac{1}{2}$  Diameter at the Bore, 1400 Pounds Weight, 8 Foot long, its Load near 3 Pound  $\frac{1}{2}$ , Shot 4 Pound  $\frac{1}{4}$  Weight, and 3 Inches  $\frac{1}{4}$  Diameter.

SALAMANDERS *Blood*, is a foolish Term that the Chymists give to the red Vapours, which in Distillation of Spirit of *Nitre*, towards the latter end, do fill the Receiver with red Clouds; they are the most fix'd and strongest Part of the Spirit; and nothing but *Nitre* yields a red Vapour in Distillation.

SAL *Armoniack*, is either *Natural*, which is found in some Parts of *Africa*, near the Line, or *Artificial*, which is made thus:

Five Parts of Urine, one of Sea Salt, or *Sal Gemma*, and half an one of Chimney-Soot, are boiled together into a Mass; which Mass being after this put into a subliming Pot, over a gradual Fire, it sublimes into the Form of that Salt, which is the common *Sal Armoniack*. It is purified by Dissolution in Water, Evaporation, &c. as other Salts.

Equal Parts of this Salt and common Salt decrepitated, are mingled, and then the Armoniack is sublimed from the Mass, which is called *Flowers of Sal Armoniack*. If instead of Sea Salt, you should use Filings of Steel, the Flowers would be yellow, and they are a little more penetrating than the former.

SAL *Circulatus Paracelsi*, the same with the Alkahest.

SAL *Polychrestum*, is a Preparation of Salt-petre, made by burning equal Parts of it with Sulphur in a Crucible, whereby 'tis deprived of its Volatile Parts.

They give it this Name from the Greek πολυχρηστος, as being good for many Uses. Tho' 'tis indeed no very good Medicine, and unless it be very white, ought not to be used.

They give it as a Purge, from half a Dram to six Drams: but there are so many other good Purgative Medicines, that there is no need of using this.

SAL *Prunellæ*, is only purified Salt-petre, having some of its most Volatile Parts separated from it, by burning upon it when melted in a Crucible over the Fire, about a 30th Part of its Weight of Flour of Brimstone. 'Tis given to cool and provoke Urine in Fevers and Quinsies; but Salt-petre purified three or four times, is certainly a much better Medi-



Medicine; for this burning of Sulphur upon it, carries off a good part of the fine and volatile Parts, and, instead of opening it, renders it more fix'd.

They often adulterate *Sal Prunellæ* with Alum, but you may distinguish it by its over whiteness, and glittering too much. This is sometimes called, *Lapis Prunellæ*, and *Chrystal Mineral*.

*SAL Volatile Oleosum*, or an *Aromatick Volatile Salt*, is made by putting to every Ounce of Volatile Salt of *Sal Armoniack* distilled with Salt of *Tartar*, and dulcified with Spirit of Wine, about a Dram and an half of some *Aromatick Oil* or *Essence*, drawn from one or more noble odoriferous Vegetables; as Cinnamon, Cloves, Rosemary, Balm, &c. and after the Spirit and Oil are well stirred and incorporated together, the Volatile Salt and Spirit is drawn off in a Cucurbit.

Some mingle all together, viz. the *Sal Armoniack*, *Sal Tartari*, Spirit of Wine, and the Powder of Cinnamon, Cloves, &c. at first, and then distil off the Volatile Salt and Spirit all at once; but the former is the best way.

The *Sal Volatile Oleosum*, is a well known and noble Medicine; 'twas first invented by *Silvius de la Boe*: 'Tis a great Cephalick and Cordial, and is much beyond any of the Volatile Parts that are not aromatized.

*SALIENT Angle*, a Term in Fortification. See *Angle*.

*SALIENT*, the Term in Heraldry for a Lion in a leaping Posture, and standing so that his right Fore-foot is in the Dexter chief Point, and his hinder left Foot in the sinister Base Point of the Escutcheon, by which it is distinguish'd from *Rampant*.

*SALIQUE Law*, *De terra Salica nulla portio Hæreditatis mulieri veniat, sed ad virilem Sexum tota terræ hæreditas perveniat*, &c. was an ancient Law made by *Pharamond*, King of the *Franks*; part of which seems to have been borrowed by our *Henry the First*, in compiling his Laws, as cap. 89. *Qui hoc fecerit secundum Legem Salicam moriatur*.

*SALIVA*, or Spittle, is a Liquor separated by proper Ducts (which they call the *Ductus Salivales*) from the Glands of the Mouth, as the *Parotides*, the *Glandulæ Nuckianæ*, the *Maxillares*, the *Sublinguales*.

'Tis probable that the Origin of the *Saliva*, is from the Arterious Blood; for as the Arteries pour Nutritious Blood into all other Parts, so they do into the Glands also; part of which they convert into their own Nourishment, part is returned by the Veins, in the Circulation, and Part (viz. of what is ferous) they separate, and bestowing a subacid Quality thereupon, make *Saliva* (or Spittle) of it.

To the Composition whereof (if not for the Separation of it) some think a Nervous Juice is contributed, the rather because larger and more numerous Twigs of Nerves are communicated to the Glands, than to other parts, which yet have a more exquisite Sense than these.

But in Refutation of this Opinion, the above-mentioned Dr. *Nuck* alledges this Experiment.

That if the Nerve that runs to any Gland, be either hard tied or cut in sunder, yet the Secretion of the *Saliva* will not thereupon cease, but will only proceed more slowly; which slowness may be attributed not to the want of any constitutive Prin-

ciple of the *Saliva*, so much as to the want of that Motion in the Gland (that to be sure depends as well upon the Nerves as upon the Pulsation of the Artery) which is necessary for the quicker dispatch of the *Saliva* through or out of the Gland.

The manner of the Secretion of the *Saliva*, is like that of the Liquor of all other Glands, and proceeds from the Conformity of the Particles of the Liquor to the Pores in the Gland; or the Mouths of the Excretory Vessel.

After its Separation, its Motion into and along the Salival Ducts is much farthered by the Muscular Motion of each Part respectively.

Now the *Saliva* is not to be reputed a meer Excrement, for it is believed by all modern Anatomists, that it serves for the farthering of the Fermentation of Meats in the Stomach, if it be not the main Ferment of it.

That it has a fermentative Quality, *Diemerbroeck* proves by this Experiment: That if a Piece of white Bread be chewed and moisten'd with much Spittle, and then be mix'd with Wheat-paste kneaded with warm Water, it will make it ferment.

Dr. *Nuck* thinks it an universal Ferment for Meats and Drinks, partaking of diverse Qualities (or Particles) but of none in an excessive Degree. That it is acid; he demonstrates by this familiar Observation:

“ That if when Milk is a boiling, one take a Spoonful to taste of, and then presently whilst it is moist with the *Saliva*, put it into the Milk again (still a boiling) the Milk will break as if some acid Liquor were mixed with it.

That it is endued with a Volatile Salt, he thinks is evident from its curing the Itch, Tetters, &c. That oleous Particles are mixed with the acid, he supposes must be concluded from its killing Quick-silver: And whereas it usually becomes frothy in the Mouth, upon its being agitated by the Motion of the Muscles of the Tongue, and those which move the lower Jaw, and that he thinks proceeds from its being endued with a Lixivial Salt and spirituous oleous and acid Particles (while the Volatile Spirit vanishes.)

*SALIVATION*, is an Evacuation of Spittle by Salivating Medicines, of which sort principally are Mercurial Preparations.

*SALLY*, in the Art of War, is the Term for the issuing out of the Besieged from their Works, and falling upon the Besiegers, to cut them off, and to destroy their Works.

*SALT*, the first of the three Hypostatical, but the third of the five Chymical Principles: Its two essential Properties seem to be, *Dissolubility in Water*, and a pretty pungent Sapor, being an active incombustible Substance; they say it gives all Bodies their Consistence, and preserves them from Corruption, and occasions all the Variety of Tastes.

There are three Kinds of Salts: *Fix'd*, *Volatile*, and *Essential*.

The *Fix'd Salt* is thus drawn: The Matter is first calcin'd, and then the Ashes are boiled in a good deal of Water, that the Salt may be the better dissolved: After this the Solution is filtrated, and all the Moisture evaporated, and then the Salt remains in a dry Form at the Bottom of the Vessel. This *Fix'd Salt* so drawn, is call'd a *Lixivious Salt*, because a kind of *Lixivium*, or Lye, was made of the Ashes of the Body calcined.

*Volatile*



*Volatile Salt*, is that which is drawn from the Bodies or Parts (chiefly) of Animals, and from some fermented, or rather putrified Parts of Vegetables: It rises quick and easily, and is the most volatile of any Bodies so called.

The *Essential Salt* is drawn from the Juice of Plants by ChrySTALLIZATION: How, see *Essential Salt*.

Mr. Boyle reckons three other Kinds of Salts, viz. *Acid*, *Urinous* and *Lixiviate*: See those Words. And he discovers whether any Liquor contains an acid Salt, or no, by dropping some of it on Syrup of Violets, for then it will turn it *red*; but if it turn it *green*, it is either of an *Urinous* or *Lixiviate* Nature: To distinguish which, he drops some of it into a Solution of Sublimate made in common Water; then if a white or milky Colour be produced, he concludes it to belong to the Tribe of *Urinous Salts*; but if it produce a Yellow or Orange Colour, he judges it to be of a *Lixiviate* Nature.

SALT *Common*, its Spirit how drawn, see *Spirit of Salt*.

Mr. Boyle proves this Principle producible by Art, as well as other. See *Sceptical Chymist*, Part ult. p. 1.

SALT. Sir Isaac Newton shews that *Salt* is compounded of a *dry Earth*, and an *aqueous Acid* joined together by *Attraction*, and that *Earth* can't be turned into Salt, unless by the mixture of so much of an *Acid*, as may make it capable of a Dissolution in Water. And as it is owing to the *Force of Gravity*, that the Sea flows round the more dense and ponderous Globe of the Earth, so will the Principle of *Attraction* (see that Word) occasion that the *aqueous Acid* may flow round the more compact Terrestrial Particles, and so compose the Particle of Salt. For by no other way (saith he) can we account for *Acid*, being in place of a *Mean*, between *Earth* and *common Water*, in order to render Salt dissolvable in the latter. And as in the great Terraqueous Globe, the most dense Bodies will by their Gravity subside in Water, and do always tend towards the Centre of the Globe, so in the Particles of Salt, the most dense Matter always endeavours to get to the Centre of the Particle. So that a Particle of *Salt* is a kind of *Chaos*, dense, hard, dry, and earthy at the Centre, but rare, moist, soft, and watery at the Surface. And hence it appears, Salts are of so durable and lasting a nature as they are; for they can scarce be destroy'd, unless the aqueous Parts be either drawn off by a great Force, or by Putrefaction, and a moderate Heat, permitted to get down into the occult *Meatus*, or Pores of the Central earthy Parts, and at last dissolve them by cutting them into small Pieces.

If *Salt* in a small Quantity be dissolved in a great deal of Water, the saline Particles, tho' specifically heavier, will not subside, but diffuse themselves equally throughout all the Water, and render it equally *salt* in all Places; which seems to shew that the Parts of the Salt do *mutually recede* one from another, and endeavour to expand themselves all manner of Ways, and to part and separate as far as the Space will permit: And this *Endeavour* shews that they have some kind of *Repelling Force*, by which they fly from one another, or at least are more strongly attracted by the Parts of the Water than by one another. For as all Bodies ascend in Water, which do gravitate less towards the Earth's Centre than the Parts of the Wa-

ter; so all the Particles of Salt which swim in Water, and are less attracted by any one Particle of Salt, than they are by the Water itself, must necessarily recede from that Particle, and give place to the Water, which is more forcibly attracted.

When a Liquor impregnated with *Salt*, hath its Moisture so far evaporated by Heat, that a *Pellicle*, *Cuticle*, or little Skin appears upon its Surface, if then it be set to cool, the Salt will shoot into Chrystals, which will be of some regular Figure: From whence it appears, that the saline Particles before their Concretion, were placed in the Liquor in *some certain Order*, and at equal Distances or Intervals; and consequently that they did act one upon another by *some kind of Force*, which is equal at equal Intervals, and unequal at unequal Distances. For the Supposition of some such Force will occasion their being disposed every where into such Orders; but without it they would ramble about, and be dispersed, perfectly irregularly in the Fluid.

In the *French Memoirs* of the Academy of Sciences for the Year 1699, there is a Method, by Mr. Homberg, of finding the exact Quantity of the Volatile acid Salt that any Liquor contains.

(2.) Their Way of making Salt at *Namptwich* in *Cheshire*, is thus (saith Mr. Ray.) The Salt-spring, or, as they call it, the *Brine-pit*, is near the River, and is so plentiful, that were all the Water boiled out that it would afford, it is thought it would yield enough Salt for all *England*.

The *Brine-pits* belong not all to one Lord; but some have one *Lead-wall*, some two, three, four, &c. A *Lead-wall* is the *Brine* of 24 Hours boiling for one House.

Two hundred and sixteen *Lead-wallings*, or thereabouts, belong to all the Owners of the Pits. No Tradesman, Batchelor, or Widower can rent more than 18 *Lead-wallings*.

They have four sworn Officers chosen annually, which they call *Occupiers of Walling*; whose Duty it is to see equal Dealing between Lord and Tenant, and all Persons concerned, to appoint how many Houses shall work at a time (which is twelve at most) to appoint a Crier (when Salt is to be made) to make Proclamation so, that all Parties concerned may put to their Fires at the same time, and so also when they shall cease; which is at a determinate Hour: And he that doth not leave off then, hath his Salt spoiled, by throwing Dirt, &c. into it.

In the Town are about fifty Houses, and every House hath four Pans, which the Officers are to see must be all exactly of the same Measure.

The Salt Water taken out of the *Brine-pit*, in boiling two Hours and a quarter, will be evaporated, and boiled up into Salt.

When the Liquor is more than luke-warm, they take strong Ale, Bullock's Blood, an Egg-shell full, the White of one Egg, and of Ale a Pint: This Mixture is put into a Pan of 24 Gallons, or thereabouts; the Whites of Eggs, and the Blood serve to clarify the Brine, by raising the Scum; which they take off just upon the boiling of the Pans, otherwise it boils in, and spoils the Salt. The older the Blood is the better, *cæteris paribus*, when the Liquor boils too fast, they don't put in any Blood, but allay it with Brine that hath been before boiled, and drained from its Salt. Crude Brine, they say, will diminish their Salt; and they



they say, the Ale serves to harden the *Corn* of the Salt.

After one Hour's boiling, the Brine will begin to *Corn*, or Granulate. Then they take a small Quantity of clear Ale, of which they sprinkle about an Egg-shell full into the Pan; but if you put in too much Ale, it will make the Liquor boil over the Pan; a little while before they put in the last Ale, they cause the Pan to boil as fast as they can; but after that very gently, 'till the Salt be almost dry, for they do not evaporate quite, *ad siccitatem*, but leave two, three, or four Quarts of Brine in the Pan, lest the Salt should burn, and stick to its Sides.

The Brine thus sufficiently boiled and evaporated, they take out the Salt, and pour it into conical Baskets (which they call *Barrows*) and in them let the Water drain from it an Hour, more or less; and then set it to dry in the Hot-house behind the Furnace.

A Barrow containing six Pecks, is sold there for Sixteen Pence.

Out of two Pans of forty-eight Gallons, they expect seven Pecks of Salt, *Winchester* Measure.

The House in which the Salt is boiled, they call the *Wyche-house*; the Vessel whereinto the Brine is by Troughs conveyed from the Brine-pit, is called the *Ship*. 'Tis raised out of the Pit by a Pump. Between the Furnace and the Chimney-tunnels, which convey the Smoke, is their *Hot-house*, where they set their Salt to dry; along the Floor whereof run two Funnels from the Furnaces, almost parallel to the Horizon, and then they arise perpendicularly; in these the Flame and Smoke running along from the Furnaces, heat the Room by the way.

At *Droitwyche* in *Worcestershire*, the Salt is boiled in shallow Leaden-pans.

They first put in the Salt-water out of the Brine-pits, and then after an Hour's boiling they fill up the Pan with the Water that drains from the Salt, set to dry in the Barrows; and after a second Hour's boiling, they fill up the Pans again with the same. In five Hours boiling the Pan grows dry, and then they take out the Salt.

In twenty-four Hours they boil out five Pans, and then draw out the Ashes; after which they put in the White of an Egg to make the Scum arise (which is partly Dust and Ashes, falling into the Pan when they are taking out the Ashes.) The Scum they take off with a Scummer, and after four Hours they begin to take out the Salt, and once in twenty-four Hours they take out a Cake which sticks to the Bottom of the Pan, and which they call *Clod-Salt*, otherwise the Pan would melt. They use there neither Blood nor Ale, and the Salt made there is extraordinary fine and white.

In *Lancashire* they make Salt of Sea-Sand thus; They pare off in dry Summer-weather the upper Part of the Sand in the Flats and Washes (which are cover'd at Full-Sea, and bare when the Tide is out) and lay it up on great Heaps.

Of this Sand they put into Troughs, bored with Holes at the Bottom, a sufficient Quantity, and then pouring Water upon it, they make a Lec, or *Lixivium*, and the Water draining through the Sand, carries the Salt with it down into Vessels placed underneath. As long as this Liquor is strong enough to bear an Egg, they keep pouring more Water still upon the Sand in the Troughs, but as soon as the Egg begins to sink, they cast the Sand

out of the Troughs, and put in new from the Heap.

This Water, thus impregnated with Salt, they boil in Leaden-pans, wherein (as above) the Water evaporating leaves the Salt behind.

At *Newcastle*, *Preston-pans* in *Scotland*, *Whitehaven* in *Cumberland*, and other Places, they make Salt in great Plenty; by boiling and evaporating the Sea-water, and in the Operation they make use of Ox's Blood, as at *Namptwich*.

From Dr. *Jackson's* Account of the Salt-works and Springs in *Cheshire*, in the *Philosophical Transactions*, I find that now they have changed their six Leaden-pans into four Iron ones, something better than Yard square, and about six Inches deep; which are set upon Iron-bars, and made up on all Sides very close, to hinder the Flame or Smoke to break through, with Clay and Bricks. Their Fuel is *Staffordshire* Pit-coal. They never cover their Pans at all, during the whole time of boiling; and their Houses are like Barns, open up to the Thatch, with a *Louvre-hole* or two to carry off the Steam, which is so great, that probably it would warp Boards, and rust Nails, so that no Timber Covering would last long; what Tiles would do, no one yet hath tried there.

The Sweepings of such Salt as is shed and scattered about on the Floor, takes up with it a good deal of Dirt, and is called *Grey-Salt*. This sells but at half the Price of white Salt, and is only used by the Poor to salt Cheese, Bacon, &c. *Catts of Salt* are made of the worst Salt, when yet wet-tish from the Pans, 'tis molded and made up with some Cummin-seed and Ashes, and so baked into Lumps at the Mouths of their Ovens; they are only used in Pigeon-houses. But *Loaves of Salt* are the finest of all for Table use.

At *Droitwyche* in *Worcestershire* they use no Blood, but only Whites of Eggs (a Quarter of one White to a Gallon of Brine) to clarify their Brine; and to granulate it, they use no Ale, nor any thing else; this Salt is much whiter and better than the *Cheshire* Salt, and a *Winchester* Bushel of it weighs half a hundred Weight.

The way of making *Bay-Salt* in *France*, is described in *Philosophical Transactions*, Numb. 51, with Figures. The Water is let in from the Sea into a first and second Receptacle, and then into a third, which is called the *Marish*. In these Beds, or *Marishes*, the Water is not above an Inch and half deep; each Bed of the *Marish* is fifteen Foot long, and fourteen broad. When it rains much on any Day, no Salt can be made in three or four Days after, and then they have Stops to hinder the Sea-water from coming into the *Marishes*. But if it rain for five or six Days, they are necessitated to empty all the Water out of the Beds by a peculiar Channel, which cannot be opened but at Low-water.

The hottest Years make the most Salt, and in the hottest part of Summer, Salt is made in *France* even in the Night: Less Salt is made in calm than in windy Weather, and the *West* and *North-West* Winds are best for that Purpose. The People draw the Salt every Day, and each Day more than an hundred Pound Weight.

SALT of Saturn, *Saccharum Saturni*, or Sugar of Lead, is the Body of that Metal opened and reduced to the Form of a Salt by distilled Vinegar.

Thus any of the Calxes of Lead, as suppose *Cerule*, is powder'd, and distilled Vinegar is poured



upon it to four Fingers Height above the Matter, an Ebullition will follow, but without sensible Heat it must be digested in a Sand-heat two or three Days, and stirred often: Then pour off the Liquor by Inclination, and digest more distilled Vinegar with the *Ceruse*, and more after that, 'till you have dissolved about half the Matter; mix all the Impregnations together in an Earthen or Glass Vessel; evaporate the Matter in a Sand-heat, 'till a small Skin, or *Pellicle*, begin to arise upon the Surface; after which place the Vessel in a cool Place, there will appear white Chrystals: Take them out, and evaporate again as before, and set the Vessel to cool, to gain the rest of the Salt: Continue this 'till you have gotten all; then dry the Chrystals in the Sun, and keep them in a Glass. 'Tis chiefly used outwardly for Diseases of the Skin; but sometimes 'tis given inwardly, from two to four Grains at a Dose in Quinsies, &c.

**SALT of Steel.** See *Vitriol of Mars*.

**SALT of Sulphur**, a Preparation in Chymistry, improperly so called, since it is only a *Sal Polychrestum* impregnated with Spirit of Sulphur, and then reduced to an acid Salt by Evaporation of all the Moisture. Some say this is a great Febrifuge.

**SALT of Tartar**, is made either by powdering what remains in the Retort after the Distillation of Tartar; or else by calcining bruised Tartar wrapped up in a Paper, 'till it turn white. Either of these must have a great deal of hot Water poured upon them to make a *Lixivium*; then the Liquor is filtrated and evaporated in a Sand-heat, 'till the Fix'd Salt remain at the bottom of the Vessel. This is the Alkali, or Fix'd Salt of Tartar. If it be exposed to the Air a few Days in an open Vessel in a Cellar, or some such moist Place, it will melt, or run into a Liquor, and this the Chymists call Oil of Tartar *per Deliquium*.

**SALT-SILVER**, was one Penny, formerly paid at the Feast of St. *Martin*, by the Servile Tenants to their Lord, by way of Commutation for the Service of carrying their Lord's Salt from Market to his *Larder*.

**SALTIER**, the Name of one of the Ordinaries in Heraldry, of the Form of St. *Andrew's* Cross.



They tell you, that anciently 'twas the Figure of an Engine, which being stuck full of Pins, was used in the Scaling of the Walls of a Besieged Place.

*Pearl*, a *Saltier Ruby*, the Coat of my Lord *Macclesfield*.

The *Saltier* is often counter-changed with the Field, and sometimes quarterly quartered, &c.

**SALVA Guardia**, is a Security given by the King to a Stranger, fearing the Violence of some of his Subjects, for seeking his Right by Course of Law.

**SALVAGE-Money**, is a Recompence allowed by the Civil Law, in lieu of all Damages sustained by that Ship that saves or rescues another which was set upon or taken by the Enemy, or by Pyrates.

**SALVATELLA**, is that Vein which from the Veins of the Arm is terminated in the little Finger.

**SALUTE**, **SALUS**, was a Coin of Gold, stamp'd by King *Henry V*, in *France*, after his Conquests there; it had on it the Arms of *England* and *France* quarterly.

**SANATIVE Waters**, are the Mineral Waters of any kind, such as the *Chalibeate* ones of *Tunbridge*, the *Vitriolick* ones of *Epsom*, &c.

**SANCTUARY**, was formerly a Place privileged by the Prince for the Safeguard of Mens Lives that were capital Offenders: Our ancient Kings of *England* permitted the Sanctuaries to protect Traitors, Murderers, &c. if within 40 Days they acknowledged their Fault, and submitted themselves to Banishment: And during that Time, if any Layman expelled them, he was excommunicated, and a Clerk was made irregular by it. But after 40 Days no Man might relieve them. Of these there were many in *England*, and one more famous than the rest, at St. *John's* at *Beverly*. How these were taken away by degrees, you may find by reading the Statutes of 26 *H. VIII*, 13. 28 *H. VIII*, 7. 32 *H. VIII*, 15. 1 *E. VI*, 12. 2 *E. VI*, 2, and 33. 5 *E. VI*, 10.

**SANDARACHA**, is by some Chymists the Term for red Arsenick; 'tis called also *Realgal*.

**SAND-bags**, in Fortification, are Bags holding about a Cubick Foot of Sand or Earth: They are used for raising Parapets in haste, or to repair what is beaten down; they are of use when the Ground is rocky, and affords no Earth to carry on their Approaches; because they can be easily brought on and off at Pleasure: There are a lesser sort of these which hold half what the former do, which are placed upon the upper *Talus* of the Parapet, to cover those which are behind, and who fire through the *Embrasures*, or Intervals, that are between them.

**SAND-HEAT**, in Chymistry, one of the Chymical Heats, consisting of hot Sand, in which Herbs, Flowers, &c. are infused in a Cucurbit.

**SANGUIFICATION**, is the turning of the Chyle into Blood; which is performed in all the Parts of the Body, and not as the Ancients imagined in some particular Parts, as the Heart, Liver, &c.

**SANGUINE**, the Herald's Term for the Colour usually called *Murvy*, beng made of Lake, with a little *Spanish* Brown; 'tis represented in Engraving by Hatches like *Purple*: 'Tis mostly used in the Coats of Knights of the Bath. When 'tis born by Nobles, 'tis called *Sardonyx*; and in the Coats of Sovereign Princes they call it *Dragon's Tail*.

**SANIES**, is a thick and bloody Pus, or Matter, issuing out of a Wound or Sore.

**SAP**, in Fortification, is digging deep under the Earth, in order to pass under the *Glacis*, and to open a Way to come under Cover to the Passage of the *Moat*. When they are got near the Foot of the *Glacis*, the Trench is carried on directly forwards, the Workmen covering themselves as well as they can, with *Blinds*, *Wool-packs*, *Sand-bags*, and Mantelets upon Wheels: When they are got to the Foot of the *Glacis*, they make *Epaulments*, or *Traverses*, on each Side, to lodge a good Body of Men. The *Sap* is made five or six Fathom from the *Saliant Angle* of the *Glacis*, where the Men are only cover'd sideways; wherefore they lay Planks over Head, with Hurdles and Earth above them. When they have forced the Enemy to quit the Cover'd-way, the Pioneers make immediately a Lodgment, and cover themselves as well as they can from the Fire of the opposite Bastion.

**SAPHÆNA**, of σαφής, *Gr. easy to be seen*, is the Vein of the Leg, or Crural Vein. It goes down



down under the Skin of the Thigh and Leg, accompanied with a Nerve which loses itself at the inner Ankle; it turns towards the upper Part of the Foot, where it gives several Branches, of which some go to the great Toe.

SAPHATUM, is a dry Scurf in the Head. See *Achor*. Blanchard.

SAPHETA, in Architecture, is the Board over the Top of a Window, and placed parallel, and opposite to the Window-board at the Bottom.

SAPONEA, is a Lambative made of Almonds. Blanchard.

SAPORIFICK Particles, are such as by their Action on the Tongue occasion that Sensation which we call Taste or Sapor. The manner of which, see in *Taste*.

SAPOROUS Bodies, are such as are capable of yielding some kind of Taste when touch'd with our Tongue; but those that afford no Taste, are called *Insipid*.

SARCOCELE, is a kind of Rupture, which consists in a fleshy Excrecence of the Testicles. Blanchard.

SARCOEPIPOCELE, a fleshy Rupture, or Protuberancy of the Omentum, either about the Navel, or in the Cods.

SARCOLOGY, *σαρκολογία*, of *σάρξ*, *Flesh*, and *λόγος*, *a Word*. A Discourse or Treatise on the Flesh and soft Parts of Human Body.

SARCOMA, is a fleshy Excrecence in the Nostrils, and chiefly in the lowest part of the Nose, where it is fleshy, without any Shape, but like the proud Flesh of an Ulcer. Blanchard.

SARCOMPHALUM, is a fleshy Excrecence of the Navel. Blanchard.

SARCOTICKS, are those Medicines which fill up Wounds with Flesh, such as by their moderate Heats, and cleansing Qualities keep Wounds and Ulcers free from Filth, and preserve the natural

Temper of the Parts, so that the Aliment easily supplies the Solution of the Parts. Blanchard.

SARDONIAN, or *Sardonick Laughter*, is an Involuntary Laughter, or rather a Convulsive Distortion of the Muscles of the Mouth, in which the Patient appears to laugh.

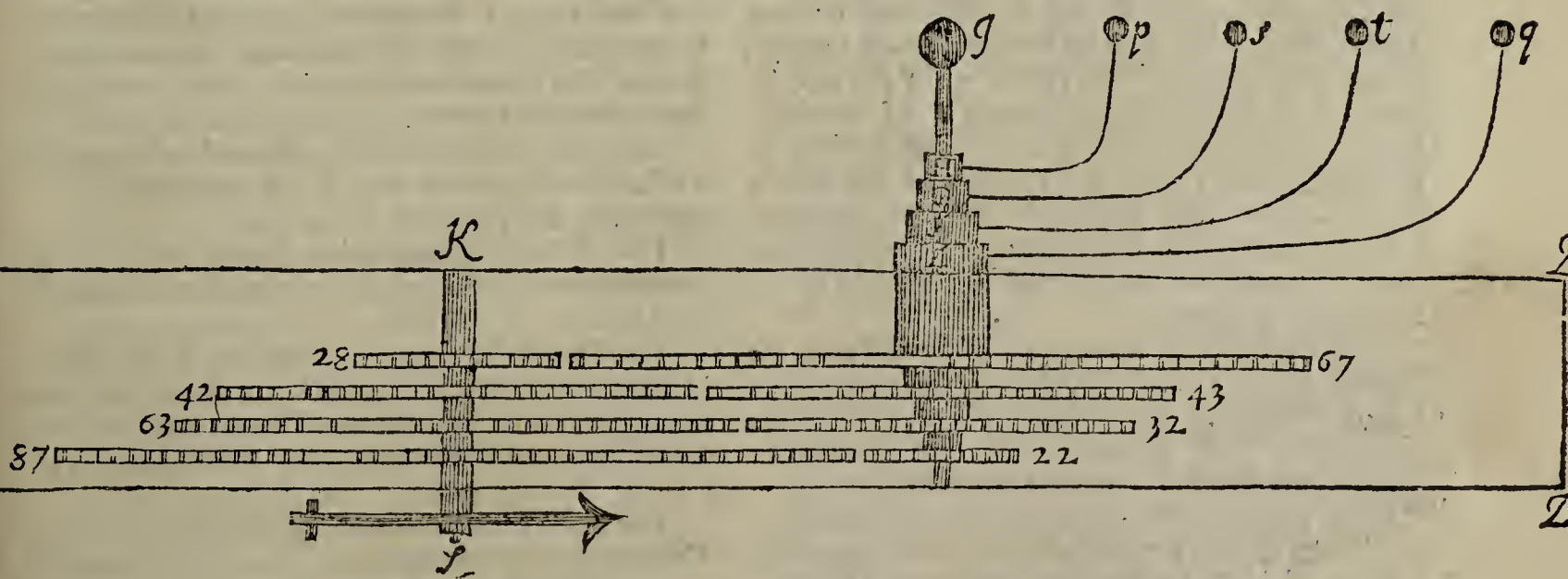
SARPEDO. See *Lichen*.

SARPLER, otherwise called a *Pocket*, is a half Sack of Wool. A Sack is eighty Tod, a Tod two Stone, and a Stone fourteen Pounds. This in *Scotland* is called *Serpliath*, and contains eighty Stone.

SARRASIN, in Fortification, is a kind of Portcullice, otherwise called a *Herse*, which is hung with a Cord over the Gate of a Town, or Fortrefs, and let fall in case of a Surprise.

SARTORIUS, a Muscle of the Leg, which receives this Denomination from the Use Taylors make of it in bringing one Leg and Thigh over the other, to fit cross-legg'd. It is also called *Longissimus Femoris*, it exceeding the rest of the Muscles of that Part in length; and *Fascialis*, from its passing over the Muscles of the Thigh and Leg like a Swathe. It arises sharp and fleshy from the Fore-part of the Spine of the *Os Ilium*, close by the *Membranofus*, and descending obliquely inwards above the *Musculus Rectus*, and *Vastus Internus*, and over Part of the *Tibiceps*, of an equal Breadth or Thickness, meets with the *Gracialis* below the Middle of the Thigh internally, and descending with it, becomes Tendinous in its Passage over the Internal and Inferior Head of the Thigh-bone (under a strict Inclosure of the *Fascia Lata*) and is inserted four Fingers Breadth below the superiour Part of the *Tibia* internally: Its Use is declared above.

SATELLITE, Instrument of Mr. Romer, Mathematician to the French King, as its Description was sent in a Letter to Mr. Flamstead, A. D. 1679, and since published in the *Artificial Clock-maker*, in the Figure annexed.



*AB* and *CD*, represent the upper and lower Plates of the Instrument.

*KL*, is an Axis or Spindle on which four Wheels are fixed, and which turn round with it, and with the Hand *L*, once in seven Days.

*EFGH*, are Sockets or hollow Arbors of four Wheels running concentrically, or one within another.

The hollow Arbor *H*, carrieth round the *First Satellite p*, and belongeth to the Wheel or Pinnion 22, which is driven by the fixed Wheel 87.

The hollow Arbor *G*, carrieth round the *Second Satellite s*, and belongeth to the Wheel 32, which is driven by the Wheel 63.

And the like of the Arbors *F* and *E*.

Within all these hollow Arbors is another fixed one included; on the Top of which is a Ball.

(*J*) representing the Planet *Jupiter*; round which the *Satellites* move, represented by the little Balls *p s t q*.

This



This *Satellite Instrument* may be added to a Watch, by causing the great Wheel, a Dial-Wheel, to drive round the Arbor *K L*, once in 7 Days.

And this Instrument may be of good use both at Sea and Land, to assist in finding the Longitude by *Jupiter's Satellites*; partly by giving Notice when an approaching Eclipse is, that we may be ready with a Telescope to observe it; and partly when any Eclipse happeneth, to shew which *Satellite* it is that is eclipsed, which is difficult to be seen in the Heavens; and partly to supply the Place of Tables, or Calculations of the *Satellite Eclipses*, which it may do for a little while, tho' it must not be long trusted to.

SATELLITES, by Astronomers, are taken for those Planets, who are continually, as it were, waiting upon, or revolving about other Planets; as the *Moon* may be called the *Satellite* of the *Earth*; and the rest of the Planets, *Satellites* of the *Sun*. But the Word is chiefly used for the new discovered small Planets, which make their Revolution about *Saturn* and *Jupiter*.

SATELLITES of *Jupiter*, are four smaller Moons or Planets moving round about the Body of *Jupiter*, as the Moon doth round our Earth. They were first discovered by *Gallilæus*, by the Help of the Telescope.

The Distances of these Satellites, from the Body of Jupiter, are as follows; from the Observations of

|   | 1                | 2                | 3       | 4                 |                                       |
|---|------------------|------------------|---------|-------------------|---------------------------------------|
| <i>Cassini</i> —————                    | 5.               | 8.               | 13.     | 23.               |                                       |
| <i>Borellus</i> —————                   | 5. $\frac{2}{3}$ | 8. $\frac{2}{3}$ | 14.     | 24. $\frac{2}{3}$ |                                       |
| Mr. Townley by the Micrometer ———       | 5. 51            | 8. 78            | 13. 47  | 24. 72            | Semi-diameters of<br><i>Jupiter</i> . |
| Mr. Flamsteed by the Micrometer —       | 5. 31            | 8. 85            | 13. 98  | 24. 23            |                                       |
| Mr. Flamsteed by Eclipses of Satellites | 5. 578           | 8. 876           | 14. 159 | 24. 903           |                                       |
| From the Periodical Times . ———         | 5. 578           | 8. 887           | 14. 168 | 24. 968           |                                       |

The Periodical Times are: Of the

|        | Days. | Hours. | Min. |                                    |
|--------|-------|--------|------|------------------------------------|
| First  | 1     | 18     | 28   | } Vid. Newton's Princip. pag. 403. |
| Second | 3     | 13     | 17   |                                    |
| Third  | 7     | 3      | 59   |                                    |
| Fourth | 16    | 18     | 5    |                                    |

Mr. Flamsteed, in *Philosoph. Transact.* Numb. 154, says, That when *Jupiter* is in a Quartile of the Sun, the Distance of the first *Satellite* from his next Limb, when it falls into his Shadow, and is eclipsed, is one *Semi-diameter* of *Jupiter*; of the second, two, or a whole Diameter nearly; of the third, three; of the fourth, five of his *Semi-diameters*, or something better, when the Parallax of the Orb is greatest. But these Quantities diminish gradually as he approaches the Conjunction or Opposition of the Sun somewhat nearly, but not exactly in the Proportion of Sines.

SATELLITES of *Saturn*. Anno 1684, in the Month of March, Mr. Cassini, by the Help of excellent Object-Glasses of 70, 90, 100, 136, 155, and of 220 Feet, discovered the two innermost; (that is, the first and second) *Satellites* of *Saturn*.

The First *Satellite* he observed to be never distant from *Saturn's Ring* above  $\frac{2}{3}$  of the apparent Length of the same Ring: And it was found to make one Revolution about *Saturn* in one Day, twenty-one Hours and nineteen Minutes; making two Conjunctions with *Saturn* in less than two Days; one in the upper Part of his Orb, and the other in the lower Part. It is distant from the Centre of *Saturn*  $4\frac{2}{3}$  of *Saturn's Semi-diameters*.

The Second *Satellite* of *Saturn*, was observed but  $\frac{1}{4}$  of the length of his Ring distant therefrom, making his Revolution about him in two Days, seventeen Hours, forty-three Minutes. This is

distant from the Centre of *Saturn*  $5\frac{3}{7}$  *Semi-diameters* of that Planet.

From a great Number of choice Observations he concluded, That the Proportion of the Digression of the Second to that of the First, counting both from the Centre of *Saturn*, is as 22 to 17.

And the Time wherein the Second *Satellite* makes its Revolution, is to the Time wherein the first makes its, as  $24\frac{3}{4}$  to 17.

The Third is distant from *Saturn* eight of his *Semidiameters*, and revolves round him in almost  $4\frac{3}{4}$  Days.

The Fourth, or *Hugenian Satellite*, as 'tis called, because discovered first by Mr. Hugen, revolves round *Saturn* in about sixteen Days, and is distant from his Centre about eighteen *Semi-diameters* of *Saturn*.

The Fifth *Satellite* of *Saturn* is distant from his Centre fifty-four *Semi-diameters* of *Saturn*; and revolves round him in  $79\frac{1}{2}$  Days. The greatest Distance between this *Satellite* and the precedent, made Mr. Hugen suspect there might be a Sixth between these two; or else that this Fifth may have other *Satellites* moving round him.

Mr. Halley, in *Philosoph. Transact.* Numb. 145, gives a Correction of the Theory of the Motion of the *Hugenian*, or Fourth *Satellite* of *Saturn*, and makes the True Time of its Period to be fifteen Days, twenty-two Hours, forty-one Minutes, six Seconds; its Diurnal Motion to be twenty-two Degrees, thirty-four Minutes, thirty-eight Seconds, eighteen



eighteen Thirds. And the Distance of this *Satellite* from the Centre of *Saturn*, to be about four *Diameters* of the *Ring*, or nine of the *Globe*; and the Place where it moves, to differ little or nothing from that of the *Ring*; that is to say, intersecting the Orb of *Saturn* with an Angle twenty-three Degrees and a half, so as to be nearly parallel to the *Earth's Equator*.

*The Periodical Times of the Satellites of Saturn, according to Mr. Cassini, are of the*

|        | Days. | Hours. | Minutes. |
|--------|-------|--------|----------|
| First  | 1     | 21     | 19       |
| Second | 2     | 17     | 43       |
| Third  | 4     | 12     | 27       |
| Fourth | 15    | 23     | 15       |
| Fifth  | 79    | 22     | 00       |

**SATELLITES.** Dr. Gregory, in his excellent Astronomy, hath demonstrated, that if a Satellite describe an Elliptick Orbit round a Planet, placed in one of the *Foci* of that *Ellipsis*, the greater *Axis*, or the *Line of the Apses*, will with an Angular Motion twice advance forwards, *viz.* in the two *Syzygies*, and twice recede backwards, *viz.* when in *Quadrature* to the Sun.

And that this Force of Progression is near twice as great as that of the Recess, and therefore the Line of the *Apses* in every Revolution of the Satellite, will advance more forward than it recedes backward; and that by the Excess of this Progression, the *Apses* will move *inconsequentia*, p. 298.

If a Satellite move round a Planet in an Eccentric Orbit, the Eccentricity will be twice changed in every Revolution, and in each Revolution will be greatest, when the Satellite is in the *Syzygies* with the Sun, and least when it is in the *Quadratures*; and will be continually increasing from the *Quadratures* to the *Syzygies*, and decreasing from the *Syzygies* to the *Quadratures*, p. 302.

If a Satellite revolve round a Planet in an Orbit, whose Plane is inclined to the Plane of the Orbit of the Planet round the Sun, then will the Line of the *Nodes* move *in antecedentia*, with an unequal Angular Motion; swiftest when the *Nodes* are in *Quadrature* to the Sun, after this slower, and at last, when the *Nodes* are in the *Syzygies*, will be quite at rest. In the intermediate Places between the *Quadratures* and *Syzygies*, the *Nodes* will recede slower; and in every Revolution of the Satellite, will either be Retrograde or Stationary, be carried backward, or move *in antecedentia*, and in each Revolution will recede fastest, all things consider'd, when the Satellite is in the *Syzygies*, p. 304.

The Inclination also of the Plane of the Orbit of the Satellite, to that of the Planet, will be continually changing, and will be greatest when the *Nodes* are in the *Syzygies* with the Sun, and least, *cæteris paribus*, when they are in the *Quadratures*, p. 307.

And all the Inequalities in the Motions of the Satellites will be a little greater when they are in Conjunction with the Sun, than when they are in Opposition to him, p. 310.

**SATURN**, in the *Leipsick Acts* for September, 1684, there is a new System of the Phænomena of *Saturn* and his Ring, by Mr. Gallet, and taken from the *French Journals* of June, 1684.

It doth not appear by any Astronomical Observations, that *Saturn*, like the other Planets;

which have Satellites, revolves round his own *Axis*; but the contrary seems to be the Case. For in *Jupiter* and the *Earth*, which do turn round their *Axes*, the Equatorial *Diameters* are longer than Polar ones, or their *Axes*, but no such thing hath been found in *Saturn*.

Each Surface of the Ring of *Saturn* seems to be plain and smooth, without any such mountainous Inequalities as the *Earth's Surface* and the *Moon's* hath; because it is not visible, tho' illuminated by the Sun, but only when the Eye is elevated some few Degrees above its Plane. 'Tis either Fluid, therefore, like Water, or Solid, like Ice or Glafs. If it be a *Fluid*, it moves round *Saturn* with a Circular Motion; but if it be of a solid Substance, it is not yet determined, whether it move round the Planet or not. And since the Figure of *Saturn's Ring* is exactly circular, it must have no *Linea Apfidum*, nor any Progression of it: But because the Plane of the Ring hath a large Elevation above the Plane of the *Ecliptick*, *viz.* making with it an Angle of thirty-one Degrees, the *Nodes* will recede, but yet very slowly, according to the manner of the other Planets.

**SATURN**: The Proportion of the Body of *Saturn* to our *Earth* is about 30 to 1.

The Periodical Time of *Saturn's* Revolution about the Sun, is in the Space of 30 Years, or 10950 Days.

The Semi-diameter of *Saturn's* Orbit, is almost ten times as big as that of the *Magnus Orbis*, and therefore is of *English Miles* 946969690.

According to Mr. Cassini, *Saturn's* greatest Distance from the *Earth* is 244330, his mean Distance 210000, and his least Distance 175670 Semi-diameters of the *Earth*.

Mr. Hugen found the Inclination of the Ring of *Saturn* to the *Ecliptick*, to be an Angle of 31 Degrees.

Mr. Azout asserts, That the remote Distance of *Saturn* from the Sun doth not hinder, but that there is Light enough to see clear there, and more than in our *Earth* in Cloudy Weather.

In an Observation which Cassini made June 19, 1692, of a precise Conjunction between a Fix'd Star, and one of *Saturn's* Satellites, he saith, That with his 39 Foot Glafs, he could plainly see the Shadow of *Saturn's* Globe to be in part Oval upon the hinder Part of his Ring. The Diameter of *Saturn* at the time of this Observation, appeared to be 45 Seconds.

The Diameter of *Saturn* to that of his Ring is as 4 to 9.

And the Diameter of the Ring seen from the Sun, would be but 50 Seconds; and therefore the Diameter of *Saturn* seen from thence would be but 11 Seconds, as Mr. Flamsteed found by measuring it. But Mr. Newton thinks it ought to be accounted but as 10 Seconds, or 9 Seconds; because he supposes the Globe of *Saturn* to be a little dilated by the unequal Refrangibility of Light.

Capt. Halley, in his Preface to the Catalogue of the Southern Stars, says, He found *Saturn* to move slower than the Astronomical Tables represent him.

The Distance of *Saturn* from the Sun, is about ten times as great as that of our *Earth* from him; and therefore that Planet will not have above the hundredth Part of the Influence of the Sun which we have; and consequently cannot be habitable by such Creatures as live on our *Globe*, unless there



be some unknown way of communicating Heat to him.

Dr. Gregory, in his Astronomy, makes the Semi-diameter of the Ring of *Saturn* to that of the Planet, as  $2\frac{1}{4}$  to 1; and the Interstice between the Planet and the Ring, is the Breadth of the Ring.

How the Ring of *Saturn* will appear in all Parts of the Orbit of the Planet, to an Eye placed at the Sun, or at the Earth, the same learned Astronomer shews in his *Astron. Phy. & Geometr.* Lib. IV. Prop. 69, 70.

If an Eye were placed in *Saturn*, the Diameter of the Sun would appear ten times less than it doth to us almost; and consequently, his Disk, Light and Heat will be there ninety times less. *Saturn's* Year is almost thirty of ours, but the Length of his Day is yet uncertain, because the Time of his Revolution round his Axis is not yet known: But Mr. *Hugens* judges they are not longer than the Days in *Jupiter*. That great Astronomer supposeth the Axis of *Saturn* to be perpendicular to the Plane of his Ring, and of the Orbits of the Satellites: If so, then there will be the same Position of the Equator and Poles (as to the Fix'd Stars) as there is in our Earth: The same Pole Star and the Fix'd Stars will appear to rise and set after the same manner, in the same Latitudes. There is a vast Inequality in the Length of the Day in several Parts of this Planet; and as great a Diversity of Summer and Winter; which depends on the Quantity of the Inclination of the Plane of the Equator, to the Plane of the Orbit of *Saturn* round the Sun; which *Hugens* makes to be 31. Degr. which is almost one Third more than in our Earth, where yet the Differences and Variety of Seasons and Weather are very sensible. For in *Saturn*, in the Latitude of 50 Degr. the longest Day will have no Night at all, and the longest Night will have no Day. And the two Frigid Zones will be each of them 62 Degr. broad, at least ten times as large as the whole Surface of our Earth. The Eye thus placed, will be able to discern none of the Planets but *Jupiter*, which will appear always to accompany the Sun, and never to be from him above 37 Degr. The Parallax of the Sun in *Saturn*, is but nine Seconds, and therefore insensible; but the Parallaxes of all his Moons or Satellites, are very considerable, and therefore their Distances from him will be easily computable.

But what an Eye placed in *Saturn* would most admire, is the Ring of that Planet; the only thing of that nature that is discovered in any of the Planets. *Tho. Kepler* in his *Epitome Astron. Copernic.* Lib. IV. p. 586, and after him Capt. *Halley* in his Enquiry into the Causes of Variation of the Needle, *Philos. Transact.* Numb. 195, do suppose our Earth may be composed of several Crufts or Shells one within another, and concentric to each other. And if so, then 'tis possible the Ring of *Saturn* may be the Fragment or remaining Ruins of his formerly exterior Shell, the rest of which is broken or fallen down upon the Body of the Planet. And if *Saturn* ever had such a Shell round it, its Diameter would then have appeared as big to an Eye at the Sun, as that of *Jupiter* doth now, when seen from thence.

Since the outward Margin of the Ring is distant from *Saturn*  $2\frac{1}{4}$  of *Saturn's* Semi-diameter, this cannot be seen at the Distance of 64 Degr. from *Saturn's* Equator (in whose Plane the Ring is placed.) Therefore a Spectator placed in a La-

titude higher than that, can never see the Ring at all; so that there is a Zone of almost 53 Degr. broad towards either Pole, to whom this famous Ring can never appear. And as the Spectator shall move nearer the Pole, first one, then the second Satellite, next the third and fourth; and when he is come within one Degree of the Pole, even the fifth Satellite cannot be seen, unless by Refraction; and in the Winter-time, neither Sun, Moon, nor any Planet, will be there visible, unless perhaps a Comet.

If the Eye be supposed to be placed in the Equator of *Saturn*, or in the Zone nearly adjoining, it can never see those Stars that are in or very near the Equator, nor any one of the Satellites; because the Ring will always hide them; and then at the Equinoxes it cannot see the Sun; and if it were any where else placed, it could not then see the Ring; because neither of its Faces will then appear illuminated by the Sun.

The Breadth of this Ring it is hard to determine from our Earth, because its Thickness is so small: But Mr. *Hugens* makes it to be about six hundred German Miles.

For one half of *Saturn's* Year (*viz.* fifteen Years of ours) only one Face of the Ring will be enlighten'd by the Sun: Whence the Inhabitants which may be supposed to live in that Hemisphere, to which this Face of the Ring is turned, or to whom it is Summer, will see that Part of the Ring which is above their Horizon, shining faintly by Day (as our Moon doth when the Sun is above our Horizon) but brighter and stronger by Night, as our Moon doth in the Sun's absence: And after Sun-set, the Eastern part of this enlightened Arch will fall within the Shadow of *Saturn*; which Shade will ascend as Night comes on, and at Midnight will be at the highest; and then will descend again towards the Western Part of the Ring, according as the Sun comes more and more to the Eastward.

This enlighten'd Arch will always shew how to describe a Meridian Line; for a Plane perpendicular to the Horizon, and passing through the Vertex of the Ark, will be in the true Meridian.

To an Eye placed any where without, and at less than 50 Degr. Distance from the Equator, this enlighten'd Ark of the Ring will appear Concave as well as Convex, like a kind of Furnace or Vault, rising above the Horizon: But to an Eye or more than 52 Minutes, and less than 64 Degr. distant from the Equator, the hollow or concave Part will not be visible; but there will appear a brightish Body arising as it were out of the Ground, and contiguous to the Horizon.

For the other half of *Saturn's* Year, while the Sun declines towards the depressed Pole, or during the fifteen Years Winter, the Ring will not be visible, as having not that Face illuminated which is obverted to the Spectator's Eye; but however will render itself sensible, by covering from the Sight such Stars and Parts of the Heavens as are opposite to it, or apparently behind it. The Shade of the Ring also will be extended more and more towards the nearer Pole; so that to an Eye placed any where within the aforesaid Space, the Sun, when he attains such a certain Declination, will appear to be covered or eclipsed just at Noon, and then streight to emerge out of the Shadow. The next Day, the like Phænomenon will happen, but the Eclipse will begin sooner, and will be over later:



ter: And these Meridian Eclipses will daily encrease in their Duration, until the middle of Winter; and then they will decrease again gradually, 'till at last they will come to nothing again; viz. When the Sun returning from the Tropick, hath the same Declination as he had when these Meridional Eclipses began.

And this will happen, if an Eye be placed in any Latitude greater than 25 or 26 Degrees; but if in a Latitude less than this, when the Meridian Darknes is of the greatest Duration, the Sun will suddenly appear just in the Meridian, and then streightway will be eclipsed again. The next Day there will appear the like sort of Light, but it will last longer; and this Meridian Light will grow still longer and longer in Duration, 'till Mid-Winter, and then (like the Darknes above-mentioned) it will be continually decreasing, until it quite disappear.

And from hence 'tis plain, that there is the greatest Difference between Summer and Winter in the Globe of *Saturn*, of all the other Planets; and this both on the Account of the long Duration of each, and the great Declination of the Sun from the Equator; and also, by reason of these Meridional Darkneses in the Winter, arising from the Ring's eclipsing the Sun. *Gregor. Astr. Phy. & Geom. Lib. 6. Prop. 6. p. 480.*

**SATURN** in *Chymistry*, is a Name given to Lead, on account that this Metal is supposed to lie immediately under the Influence of this Planet.

**SATURN** in *Heraldry*, is the Black Colour in the Coats of Arms of Sovereign Princes; and answers to Diamond in the Coats of Noblemen, and Sable in the Coats of Gentlemen.

**SATURNINE**, *Saturninus*, an Epithet applied to Persons of dark, fullen, melancholick Complexions, they being supposed to be under the Predominancy of *Saturn*, or that *Saturn* was ascendant at the Time of their Birth.

**SAUSAGE**, is a long Piece of Cloth, the Sides whereof are sewed in Form of a Gut, as large as to contain a Tennis Ball. It is dipp'd in Pitch or Tar, and filled with Powder, on purpose to serve as a Train to set Fire to Mines, Fougades, or Bomb-Chests. Two of these *Sausages* are commonly applied to every Mine, to the end that if one should fail, the other may take effect.

**SAUCISSONS**, are a sort of Faggots made of great Boughs of Trees bound together in the middle and at both ends. Their use is much the same with the Bavins or small Faggots, viz. to consolidate the Way for Carriages, to make Traverses or Parapets in Ditches full of Water, &c.

**SAVER default**, in Law, is Word for Word to excuse a *Default* in Court, comes afterwards and alledges a good Cause why he did it, as Imprisonment at the same time, or such like.

**SAW**, is an Instrument very well known in the general, as well as its use. But they reckon these several sorts of Saws. 1. The *Pit-Saw*, which is used to saw Timber and Boards, and to cut off Scantlings, Quarters or Battens from any Piece of Timber. The Matter to be sawed is sometimes laid over a Pit, and sometimes on great Tressels above Ground. 2. The *Whip-Saw* is used by Joiners, to cut off such Pieces of Stuff as the Hand-Saw will not easily notch through. 'Tis drawn by two Men, and the Timber is placed on Tressels in order to be cut. 3. The *Hand-Saw*, which is to be used by a single Man, and usually with one Hand.

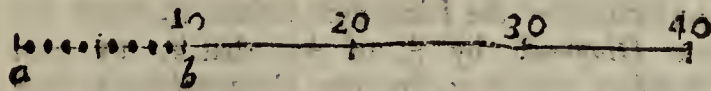
4. The *Frame-Saw*, or *Bow-Saw*, is a Saw with Cheeks made to it, and with a twisted Cord and Tongue in the middle to draw the upper Ends of the Cheeks closer together, that the lower Ends may be farther asunder, and so strain the Saw the streighter. 5. The *Tennon-Saw*, which is a thin Saw with a Back to it, to keep it from Bending. 6. The *Compass-Saw*, which is designed to cut a Round, or any Compass-Kerf; wherefore its Edge must be made broad, and the Back thin, and the Blade narrow, that the Back may have a wide Kerf to turn in, and so the easier follow the Edge.

**SCALA.** *William I.* appointed the *Arms* which before him had been usually answered in Victuals, to be converted into Money numbred, and directed the whole in every County to be charged on the Sheriff, who brought it into the *Exchequer*; adding, that the Sheriff should make the Payment *ad Scalam*, i. e. as *Gervase of Tilbury* expounds it, he should pay Sixpence over in every Pound to make up the full Weight, and nearly the intrinsic Value. And this was agreed on, as an easy way to remedy the defective Weight of Money, and to avoid the Trouble of weighing all Money that was brought into the *Exchequer*.

**SCALADOE**, is the mounting of the Wall of a Fortify'd Town or Castle, with Scaling Ladders.

**SCALE**, in Mathematicks, signifies any Measures or Numbers which are commonly used; or the Degrees of any Ark of a Circle, or of such Right Lines as are divided from thence; such as *Sines*, *Tangents*, *Chords*, *Secants*, &c. drawn or plotted down upon a Ruler, for ready Use and Practice in Geometrical or other Mathematical Operations. The several Kinds of which follow; as,

1. *Scales of Equal Parts*; of which that commonly called a *Plane Scale*, is made by drawing any Right Line, as *a z* on Paper, *Pasteboard*, &c. Then with a Pair of Dividing Compasses run along ten small Divisions from *a* to *b*; and then setting off the whole Division *a b*, as often as you please, toward the Right-hand, as you see.

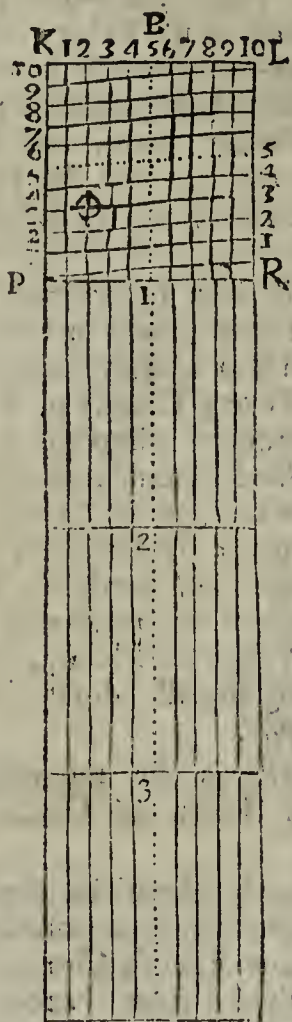


For then may each of these great Divisions represent ten Miles, as in a Scale of Miles in a Map; and consequently each of the smaller Divisions one Mile: Or the Distance *a b* may be an Inch, and the lesser Divisions will be tenth Parts of Inches: Or the larger Divisions may be Leagues at Sea, &c. Or, in a Word, this Scale may well enough represent any Measures or Numbers whatsoever, whose Parts are equal one to another. But this is more accurately done by a

*Diagonal Scale*, of which the larger Divisions are commonly of an *Inch*, or of *half an Inch*; and are made upon eleven Lines, so as to include ten equal Spaces (as in the Figure B) which are all cut at right Angles to the Transverse Lines *P R*. Then *P K* being divided into 20 equal Parts, as also *R L*; and from the Points of Division upon the Line *P K*, to those on the Line *R L*, are ten Diagonals drawn; the first beginning at *P*, and ending at the first Division above *Z*. The second beginning at the first Division



Division above P, and ending at the second above R, &c. In short, they are all drawn from one Division less from P, to one Division more from R.



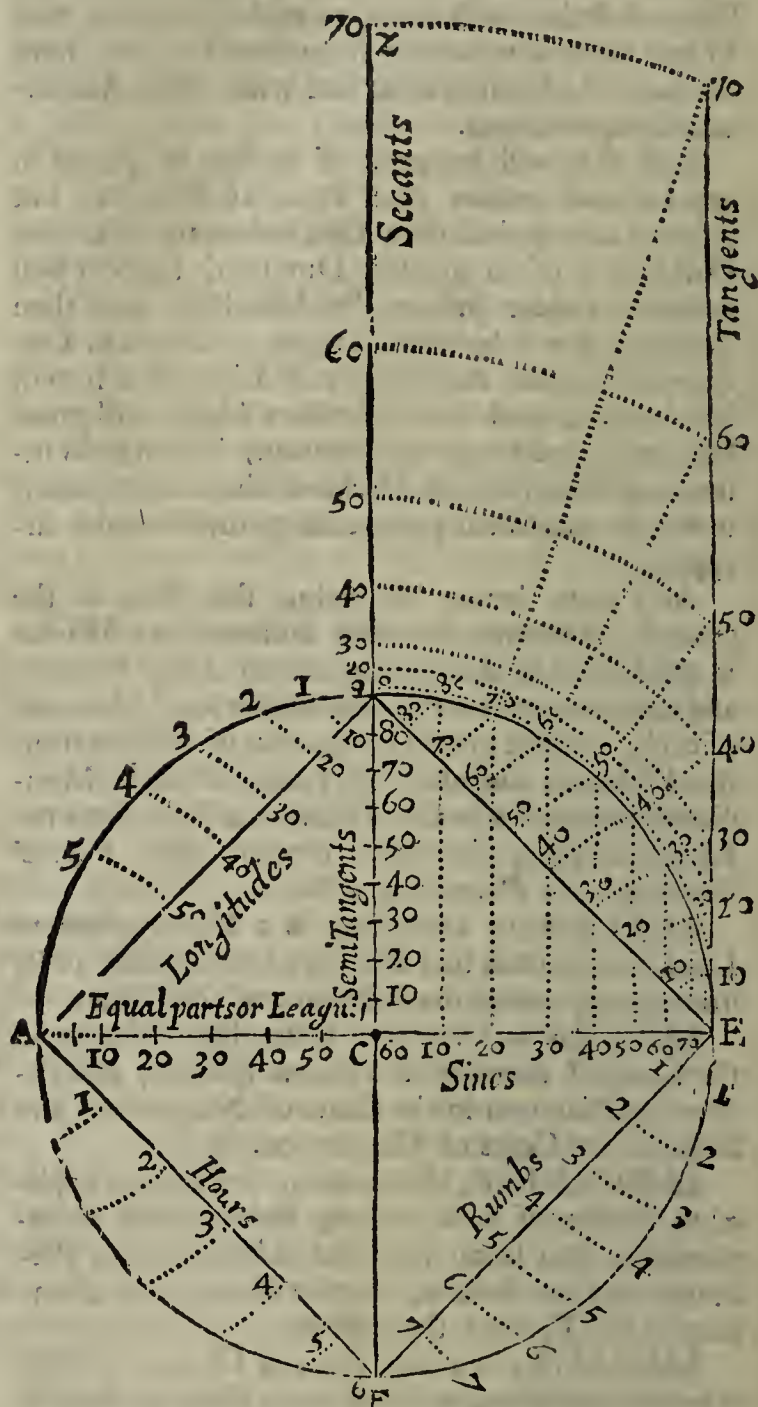
So that every *Diagonal*, by that time it hath passed from the first Line to the eleventh, is a whole tenth Part of an Inch farther distant from the Line P R, than at the Point upon the first Line whence it was drawn. And every one of these *Diagonals* is divided into ten equal Parts by the Parallel Line drawn along the Scale, and numbred on the Top from one to nine. Whereby 'tis evident; that the Interfection of any of these Parallel Lines numbred at the Top; with any *Diagonal*, is farther distant from the Line P R than the Interfection of the Line next before it, with the same *Diagonal*, by  $\frac{1}{10}$  of  $\frac{1}{10}$ ; that is, by  $\frac{1}{100}$ . Therefore you may, by the *Diagonal Scale*, take the hundredth Part of an Inch very exactly.

The Use of these Scales, viz. of *Equal Parts*, or the *Diagonal*, is chiefly, To lay down any Measure taken; or a Line being laid down, to find how much of the Measure that Line containeth.

The way to do both which, is to reckon the Unities from P towards R; the Tens from P towards K; and the Hundreds, from 1 to 2, 3, 4, &c. of the great Divisions. Thus, for 432, count two of the Parallel Lines downward, and then run your Eye forward to the Right-Hand, 'till you come to the third *Diagonal*, as at o; then the Compasses on the Line, extended from o to 4, will represent 432.

The Plain SCALE (for Sea Uses) has also set thereon the Scale of Chords, Natural Signs, Tangents, Semi-tangents, Seconds, Rhombs, Hours, Leagues, and Longitudes, with the *Diagonal Scale* on the Back-side, and some others, according as there is room. The way of deducing or graduating all which from the equal Divisions, or Degrees

of the Circumference of a Circle, is, as in the following Scheme.



Having described the Circle A F E 90, and quartered it with two Diameters A E F 90, at Right Angles.

1. Divide the Ark E 90 into nine equal Parts, and transfer the Divisions to the Right Line E 90, and that will be a *Line of Chords*.
2. Then Perpendicular to the Radius C E, erect the Tangent E 70; then a Ruler laid over C, and the equal Divisions of the Ark E 90, gives E 70, the *Tangent Line* truly divided.
3. If through the Divisions, 10, 20, 30, &c. on the Ark E 90, then you draw Parallels to C 90, it will divide C E, so as to make it a *Line of Sines*.
4. Setting one Foot of the Compass in C, extend the other to the several Divisions on the Tangent Line E 70, and describe the Arches 10, 10; 20, 20; 30, 30; &c. and the Line Z 90, will be a true *Line of Secants*.
5. A Ruler from A, to the several Divisions of the Ark E 90, divides the Line C 90, into a *Line of Semi-tangents*.

6. Divide



6. Divide the Ark E F, into eight equal Parts, and setting one Foot in E, transfer the Divisions of the Ark 1, 2, 3, &c. to the Right Line E F, and it shall be the *Line of Rhumbs*.

7. Divide F A, into six equal Parts, and setting one Foot in A, transfer them to the Strait Line F A, and that will be a *Line of Hours*.

8. Divide the Radius A C, into six equal Parts, and thro' each Division draw Lines parallel to C 90; those Lines will divide the Quadrant A 90, into six unequal Parts, and those transferr'd into the *Chord* A 90, makes the *Line of Longitude*.

9. And the equal Divisions on the Radius A C, being subdivided, is the *Line of Leagues*, or *Line of equal Parts*.

SCALE, in *Geography*, &c. is a Line divided into equal Parts, placed at the Bottom of a Map, to serve as a common Measure to all the Distances and Places of the Map.

A *Front SCALE*, in *Perspective*, is a right Line in the Draught, parallel to the horizontal Line; divided into equal Parts, representing Feet, Inches, &c.

A *Flying SCALE*, is a right Line in the Draught, which tends to the Point of View, being divided into unequal Parts, representing Feet, Inches, &c.

SCALE of the *Gamut*, or *Musical Scale*, is a kind of *Diagram*, consisting of certain Lines and Spaces drawn, to shew the several Degrees whereby a natural or artificial Voice or Sound may either ascend or descend.

The Name thereof is taken from the *Greek Letter Gamma*, which *Guido Aretinus*, who reduced the *Greek Scale* into this Form, plac'd at the Bottom, to signify from whence it was derived; so that ever since, this Scale, or *Gamut*, hath been taken for the Ground-work or first Foundation of all Musick, both Vocal and Instrumental.

But there were three different Scales in use among the Ancients, which had their Denominations from the three several Sorts of Musick, viz. the *Diatonical*, *Chromatical*, and *Enharmonical*. Which see.

SCALE of *Musick*, tho' we find mention of several *Distances* of Musick among the *Greeks*, yet I rather think them to be *Leaps* in a single Part, than *Concords* in Composition. The *Distances* talk'd of among the *Greeks*, are the Τόσι, or Second, the Δίτοι, or Third, the Διατεσάρων, or Fourth, the Διαπέντε, or Fifth, and Διαπασών, or Eighth. But if these were design'd to denote the *Concords*, they were in the Wrong to place the *Fourth*, and more so to place the *Second*, among them. Or if such were admitted, 'tis a Wonder that the *Sixth*, which is known to be a *Concord*, was refused. But if they were used to shew the Distances by which a Voice may rise or fall, it is no Wonder that they left out the *Sixth* and *Seventh* (being Distances not to be used without better Judgment and Design than those Times would admit of) and made mention of the rest, as being common in their Musick.

The Scale of Musick among the *Greeks*, consisted but of *fifteen Notes*, or the *Distances* of two *Octaves*, viz. The first from their Μετολεμζανόμεν, VOL. II.

(which I suppose was the *Key* of their Musick) to their Μέση, and the second from their Μέση, or *Middle Note*, to their Νήτη υπερβαλλίων, or *Highest Note*, by which, I suppose, they designed only the utmost Extent of a single Natural Voice.

And their *Seven Moods*, so much talk'd of, were no more than the seven different Methods of altering their Tunes; by *Flats* and *Sharps*, placed at the beginning of a Lesson; which therefore they called μεταβολή κατὰ τόνον. Besides the Names of their Notes in the upper Octave, have no Affinity with the Names in the other; whereas in *Guido Aretinus's* Scale of twenty Notes (tho' our modern Composers in many Parts often exceed the *Scale*, both above and below) and the Notes in every Octave begin with the same Letter; that we may thereby more readily compute the *Concords* and *Discords*.

SCALES *Proportional*. See *Proportional Scales*.

SCALENI, of σκαληνός, Gr. are three Muscles of the Thorax, so called from their Figure, having three unequal Sides.

1. *Scalenus Primus*, which arises fleshy from the Fore-part of the second, third, and fourth Transverse Processes of the *Vertebrae* of the Neck; and descending obliquely forwards, becomes Tendinous at its Insertion to the first Rib: The Axillary Nerves pass between this and the following Muscles. Their Use is to draw the Superior Rib, together with the rest, upwards in Inspiration.

2. *Scalenus Secundus*, this springs fleshy from the second, third, fourth, and fifth Transverse Processes of the *Vertebrae* of the Neck, laterally (like the former) in its Descent, it becomes thin and tendinous, marching over the first Rib to its Insertion in the second, and sometimes to the third.

3. *Scalenus Tertius*, this has its beginning near the former, from the same Transverse Processes of the *Vertebrae* of the Neck; as also from the fifth and sixth of those Processes, and is soon inserted to the first Rib.

SCALENOUS *Triangles*. See *Triangles*.

SCALENOUS *Cones*. See *Cones*.

SCALENUM, of σκαληνός, Gr. a Scalenous Triangle; a Triangle whose Sides and Angles are all unequal.

A *SCALENOUS Cylinder*, is one whose Axis is inclined.

SCALPEL, in *Surgery*, a kind of Knife chiefly used in Dissection; but may be used in many other Operations, as Amputation, &c.

SCALPRUM, a Surgeon's Rasping and Scraping Iron, with which he scrapes rotten Bones.

SCAMMILI *Impares*, in Architecture, are certain Blocks, or *Zocco's*, which serve to elevate the rest of the Members of any Column, or Statue, which was placed before the Horizon, i. e. beneath the Projectures of the *Stylobata Cornices*, and other *Saillies*; and will easily be conceived by considering the Pedestals of Statues, which do well represent them.

SCAMNUM *Hippocratis*, *Hippocrates's* Bench, is an Instrument of six Ells long: 'Tis used in setting of Bones.

SCANDALUM *Magnatum*, in Law, is the special Name of a Wrong done to any high Per-



sonage of the Land, as Prelates, Dukes, Earls, Barons, and other Nobles; as also of the Chancellor, Treasurer, Clerk of the Privy-Seal, Steward of the House, Justice of the Bench, and other great Officers of the Realm, by false News or Messages, whereby Debates and Discords betwixt them and the Commons, or any Scandal to their Persons might arise; and hath given Name to a Writ granted to recover Damage thereupon.

**SCANTLING**, *Eschantillon*, Fr. a Measure, Size or Standard, by which the Dimensions, &c. of Things are to be determined.

**SCAPHA**, *σκαφή*, Gr. seu *Linter*, is the Inner Rim of the Ear.

**SCAPHOIDES**, *σκαφοειδής* of *σκαφή*, Gr. a Boat, is the third *Os Tarsi* in the Foot; 'tis joined to the Ankle-Bone, and the three hinder Bones. 'Tis called also *Os Naviculare*, from some Resemblance it has to a Boat.

**SCAPULA**, the Shoulder-blade, a broad triangular Bone, with three Processes; 'tis very thin in the Middle, but grows thicker about the Processes.

**SCAPULARIS**, *Externa* and *Interna*, are two little Veins so called, of which the former arises from the Muscles covering the *Scapulæ*; and the latter, from the Muscles which possess the Cavity of the *Scapulæ*.

**SCAPUS**, is the Term in Botany for the straight Stalk or Shaft of a Plant, standing upright like a Pillar or Column.

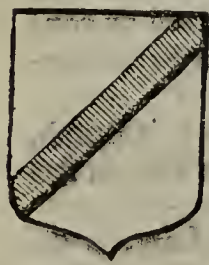
**SCAPUS**, in *Architecture*, the Fust or Shaft of a Column.

**SCARAGE**, *Scaragium*, otherwise called *Escharge*, *Shewage* and *Scheawing*; and in a Charter of *Hen. II. to Canterbury*, 'tis written *Scewinga*, was formerly a kind of Toll or Custom, exacted by his Majesty's Sheriffs, &c. of Merchant Strangers for Wares, shewed or offered to Sale within their Precincts. This is now prohibited by Statute, 19 *Hen. VII. c. 8.* But the City of *London* doth still retain the Custom. *Cowel's Interpreter*. The Officer that collected this Toll, was called the *Scabaldue*.

**SCARFED**, in the Sea-Carpenters Language, is the same as *Pieced*, or fastened or joined: Thus they say the Stem of a Ship is *Scarfed* into her Keel; and they imply by it, that the two Pieces are shaped away slanting, so as to join with one another close and even; which they call *Wood and Wood*.

**SCARIFICATION**; 'tis an Incision of the Skin with a Pen-knife, or Lancet. This is done either with or without Cupping-Glasses; without Cupping-Glasses, if there be any Mortification or Gangrene, because the Separation is by no Means to be hastened; with Cupping-Glasses, if there be a Necessity to take away Blood.

**SCARP**, in *Fortification*, is the Foot of the Rampart-Wall, or the Sloping of the Wall from the Bottom of the Work to the Cordon on the Side of the Moat.



**SCARPE**, a Term in Heraldry, probably derived from the *French*, *Escharpe*, signifying the Scarfe which Military Commanders wear for Ornament. It is born something like a *Batton Sinister*, but is broader than it, and is continued out to the Edges of the Field;

whereas the Bottom is cut off at each End. He beareth Argent a Scarpe, Azure.

**SCELOTYRBE**, is a wandering Pain in the Legs, proceeding chiefly from the Scurvy. Hence the Water proper for this Distemper, is called *Aqua Scelotyrbitis*. *Blanchard*.

**SCENOGRAPHY**, in *Perspective*, the *Scenographick* Appearance of any Figure, Body, or Building, is that Side that declines from, or makes Angles with that straight Line imagined to pass through the two outward convex Points of the Eyes, generally called by Workmen, the *Return* of a Fore-right Side; and differs from the *Orthographick* Appearance in this, that the latter represents the Side of a Body, or Building, as it is seen, when the Plane of the Glass stands parallel to that Side: But *Scenography* represents it as it seems through a Glass, not parallel to that Side.

In *Architecture* and *Fortification*, *Scenography* is the manner of delineating the several Parts of a Building, or Fortrefs, as they are represented in *Perspective*.

**SCENOGRAPHY**, in *Perspective*, a Representation of a Body on a Perspective Plane, or a Description thereof in all its Dimensions, such as it appears to the Eye. The *Ichonography* of a Building, &c. represents the Plan, or Ground-work of the Building; the *Orthography*, the Front, or Upright, thereof, and the *Scenography*, the whole Building, Front, Sides, the Height and all. The Word is formed from the *Greek* *σκήνη*, *Scene*, and *γραφία*, *Description*.

To exhibit the *Scenography* of any Body: 1. Lay down the Basis, Ground-plot, or Plan of the Body, in the Perspective *Ichonography*, according to the Method laid down under the Article *Perspective*. 2. Upon the several Points of the Plan raise the Perspective Height; thus will the *Scenography* of the Body be compleated, excepting that a proper Shade is to be added. The Method of raising the Heights is as follows.

On any Point given as C (*Fig. 1.*) to raise a Perspective Altitude, answerable to an objective Altitude PQ, on the Terrestrial Line raise a Perpendicular PQ equal to the given objective Altitude: From P and Q, to any Point, as T, draw right Lines PT and QT. From the given Point C draw a right Line CK, parallel to the Terrestrial Line DE, meeting the right Line QT in K. In the Point K, upon the Line KC, erect a Perpendicular IK, this IK is the *Scenographic* Altitude required. The Application of this general Method of drawing the *Scenography* of a Body, is not so obvious, in every Case, but that it may be necessary to illustrate it a little by a few Examples.

To exhibit the *Scenography* of a Cube, view'd by an Angle; 1. As the Basis of a Cube viewed by an Angle, standing on a Geometrical Plane, is a Square viewed by an Angle, draw a Square, view'd Angular-wise, on the Perspective Table, or Plane. 2. Raise the Side HI (*Fig. 2.*) of the Square perpendicularly on each Point of the Terrestrial Line DE; and to any Point, as V, of the Horizontal Line HR, draw the right Line VI and VH. 3. From the Angles d, b and c, draw e 1, d 2, &c. parallel to the Terrestrial Line DE. 4. From the Points 1 and 2, raise L 1, and M 2, perpendicular to the same. Lastly, Since HI is the Height to be raised in a, L 1 in c and b, and M 2 in d; in a raise the Line f a perpendicular to f a; in b and c raise b g and c e perpendicular to b c 1; and, lastly,



# SCENOGRAPHY in Perspective.

Fig. 1.

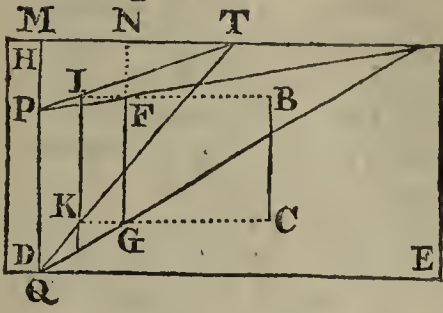


Fig. 4.

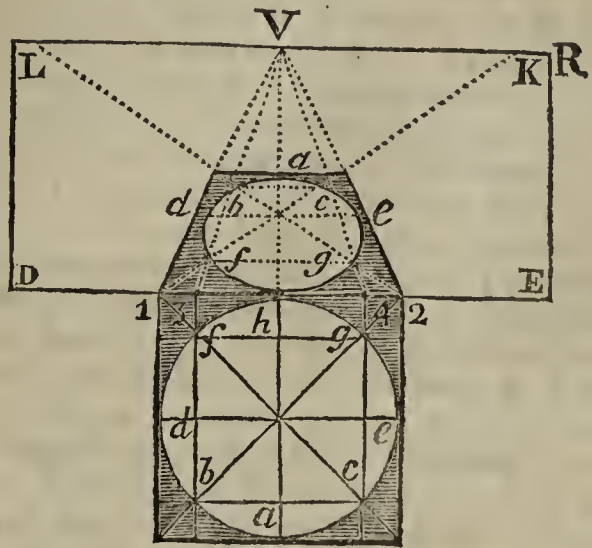


Fig. 2.

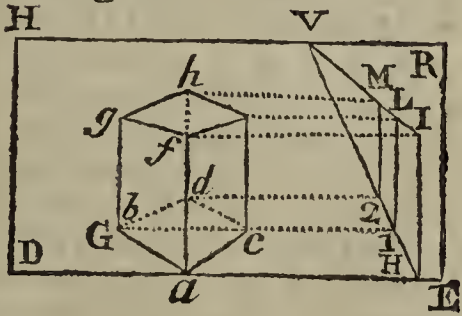


Fig. 5.

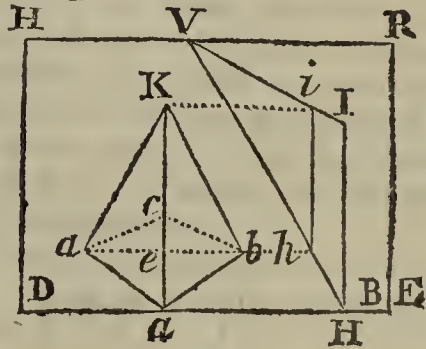


Fig. 3.

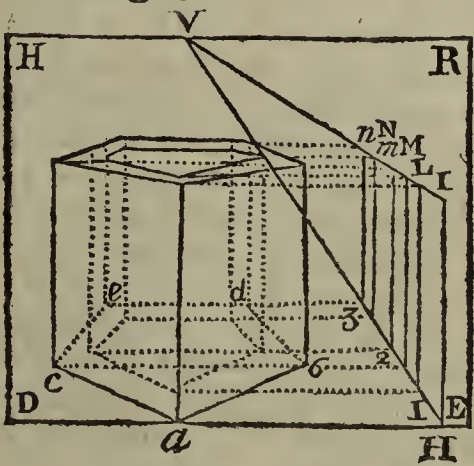


Fig. 6.

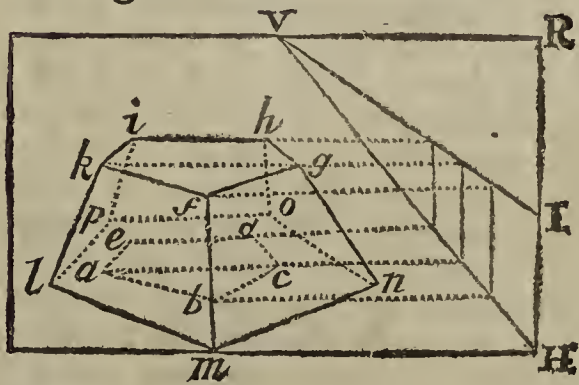
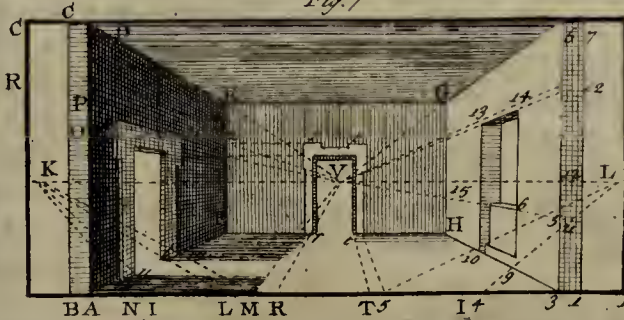
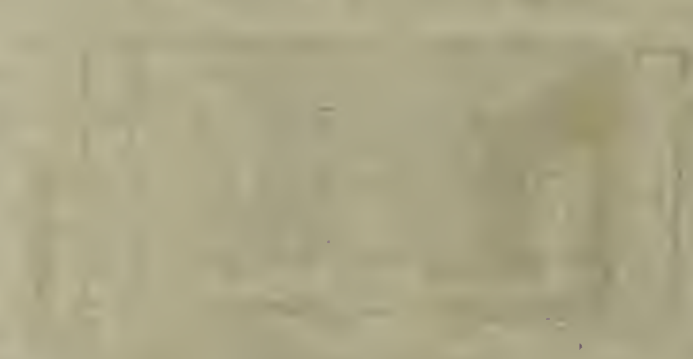
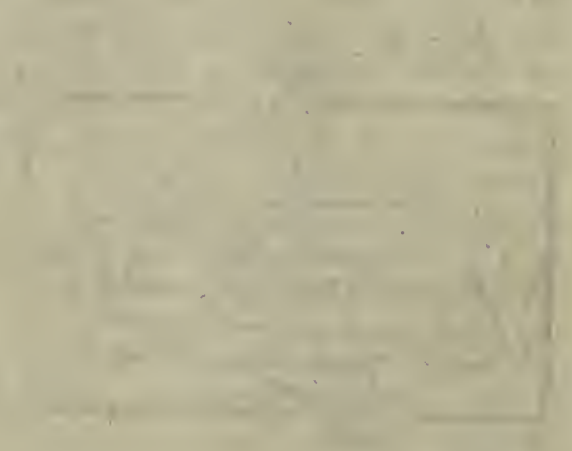
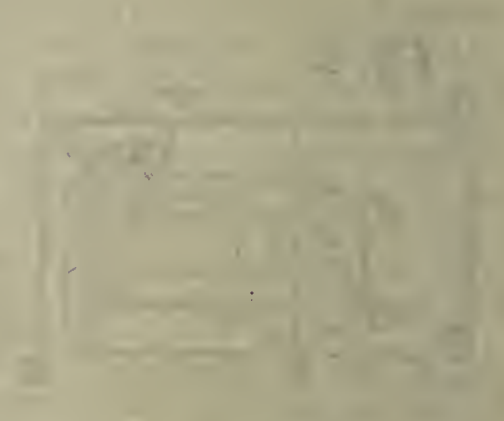
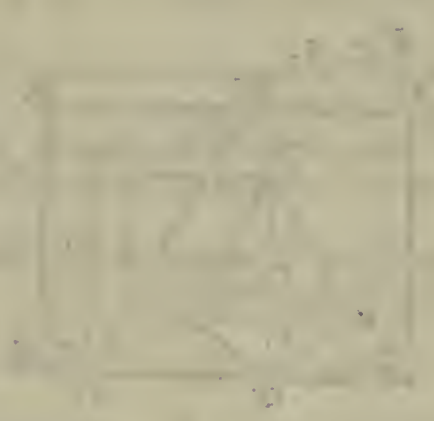


Fig. 7.





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lastly, raise  $dh$  perpendicular to  $d2$ , and make  $af = HI$ ,  $bg = ec = L1$ , and  $hd = M2$ ; if then the Parts  $gb$ ,  $ef$  be connected by right Lines, the *Scenography* will be compleat.

To exhibit the *Scenography* of a hollow Quinquangular Prism: 1. Since the Base of a hollow Quinquangular Prism, standing on a Geometrical Plane, is a Pentagon, with a Limb or Breadth of a certain Dimension; find the Appearance of this Pentagon on a Table, or Plane. 2. On any Point, as  $H$ , of the Terrestrial Line  $DE$  (*Fig. 3.*) raise a Perpendicular  $HI$ , equal to the objective Altitude, and to any Point, as  $V$ , of the Horizontal Line  $HR$ , draw the Lines  $HV$  and  $IV$ . 3. From the several Angles  $a, b, d, e, c$  of the Perspective *Ichnography*, both the internal and external ones, draw right Lines, as  $b2, d3$ , &c. parallel to the Terrestrial Line; and from the Points  $1, 2, 3$ , raise Perpendiculars to the same, as  $L1, M2, m2, N3, n3$ . If these then be raised in the correspondent Points of the *Ichnography*, as in the preceding Article, the *Scenography* will be compleat.

To exhibit the *Scenography* of a Cylinder: 1. Since the Base of a Cylinder, standing on a Geometrical Plane, is a Circle, seek the Appearance of a Circle; in the Points  $a, b, d, f, h, g, e, c$  (*Fig. 4.*) raise the apparent Altitudes, as in the preceding Articles. If now their upper Lines be connected by Curve Lines, as in the Base  $a, b, d, f, c, h, e, c$ , the *Scenography* of the Circle will be compleat.

'Tis evident that those Lines are to be omitted, both in the Plan and in the Elevation, which are not exposed to the Eye; though they are not to be disregarded, from the beginning, as being necessary for the finding of other Lines; *E. gr.* In the *Scenography* of the Cube, viewed Angle-wise, the Lines  $bd$  and  $dc$  (*Fig. 2.*) in the Base, and the  $dh$  in the Elevation, are hid from the Eye, and are therefore omitted in the Description. But since the Point  $H$  is not to be found, unless the Point  $d$  be had in the *Ichnography*, nor the Lines  $gb$  and  $de$  be drawn without the Height  $dh$ , the Appearance of the Point  $d$  is as necessary to be determined in the Operation, as the Height  $hd$ .

To exhibit the *Scenography* of a Pyramid standing on its Base, suppose, *E. gr.* it were required to delineate a Quadrangular Pyramid, viewed by an Angle: 1. Since the Base of such Pyramid is a Square seen by an Angle, draw such a Square. 2. To find the Vertex of the Pyramid  $i, e$ , a Perpendicular let fall from the Vertex to the Base, draw Diagonals mutually intersecting each other in  $e$  (*Fig. 5.*) 3. On any Point, as  $H$ , of the Terrestrial Line  $DE$ , raise the Altitude of the Pyramid  $HI$ ; and drawing the right Lines  $HV$ , and  $IV$  to each Point of the Horizontal Line  $HR$ ; produce the Diagonal  $rb$ , 'till it meet the Line  $VH$  in  $h$ . Lastly, From  $h$  draw  $hi$  parallel to  $HI$ . This being raised on the Point  $e$ , will give the Vertex of the Pyramid  $cd$ ; consequently the Lines  $dk, ka$ , and  $kb$ , will be determined at the same time. After the like manner is the *Scenography* of a Cone delineated.

To exhibit the *Scenography* of a Truncated Pyramid, suppose the Truncated Pyramid quadrangular: First then, If from the several Angles of the upper Base be conceived Perpendiculars, let fall to the lower Base, we shall have a Pentagon, with another inscribed therein, whose Sides are parallel to those of the former; this coincides with a Pentagon, furnished with a Rim or Breadth, &c. and

may therefore be delineated in the same manner. 2. Raising the Altitude of the Truncated Pyramid  $IH$  (*Fig. 6.*) determine the *Scenographic* Altitudes to be raised in the Points  $a, b, c, d$ . If now the Points  $f, g, h, i, k$  be connected by right Lines, and the Lines  $lk, fm, gn, ho$  be drawn, the *Scenography* will be compleat. By drawing two concentric Circles in a Geometrical Plan, and doing every thing else, as in this Problem, the *Scenography* of a Truncated Pyramid will be drawn.

To exhibit the *Scenography* of Walls, Columns, &c. or to raise them on a Pavement: 1. Suppose a Pavement  $AF, HI$  (*Fig. 7.*) represented in a Plan, together with the Bases of the Columns, &c. if there be any. 2. Upon the Terrestrial Line set off the Thickness of the Wall  $BA$  and  $1, 3$ . 3. Upon  $A$  and  $B$ , as also upon  $3$  and  $1$ , raise Perpendiculars  $AD$  and  $BC$ , as also  $3, 6$ , and  $1, 7$ . 4. Connect the Points  $D$  and  $6$  with the principal Point  $V$ , by the right Lines  $DV$  and  $6V$ . 5. Upon  $I$  and  $H$  raise Perpendiculars  $HG$  and  $EF$ . Thus will all the Walls be delineated. Now to raise the Pillars, &c. there needs nothing but from their several Bases (whether square or circular) projected on the Perspective Plan, to raise indefinite Perpendiculars; and on the Fundamental Line, where intersected by the Radius  $Fa$  passing through the Base, raise the true Altitude  $AD$ ; for  $DV$ , being drawn as before, the *Scenographical* Altitudes will be determined.

To exhibit the *Scenography* of a Door in a Building. Suppose a Door require to be delineated in a Wall  $DEFA$  (*Fig. 7.*) 1. Upon the Fundamental Line set off its Distance  $AN$  from the Angle  $A$ , together with the Breadths of the Posts  $NI$  and  $LM$ , and the Breadth of the Gate itself  $LI$ . 2. To the Point of Distance  $K$ , from the several Points  $N, I, L, M$ , draw right Lines  $KN, KI, KL, KM$ , which will determine the Breadth of the Door  $li$ , and the Breadths of the Posts  $cn$  and  $ml$ . 3. From  $A$  to  $O$  set off the Height of the Gate  $AO$ , and from  $A$  to  $P$ , the Height of the Posts  $AP$ . 4. Join  $O$  and  $P$  with the principal Point by right Lines  $PV$  and  $OV$ . 5. Then, from  $n, i, l, m$ , raise Perpendiculars, the middle ones whereof are cut by the right Line  $OV$  in  $o$ , and the Extrems, by the right Line  $VP$  in  $p$ . Thus will the Door be delineated, with its Posts; if the Door were to have been exhibited in the Wall  $EF GH$ , the Method were nearly the same: For, 1. Upon the Terrestrial Line, set off the Distance of the Door from the Angle, and thence also the Breadth of the Door  $RT$ . 2. From  $R$  and  $T$  draw right Lines to the principal Point  $V$ , to have the Breadth  $rt$  in the perspective Plan. 3. From  $r$  and  $t$  raise indefinite Perpendiculars to  $FH$ . 4. From  $A$  to  $O$  set off the true Height  $AO$ . Lastly, From  $O$  to the principal Point  $V$ , draw the right Line  $OV$ , intersecting  $EF$  in  $Z$ , and make  $rr$  and  $tt$  equal to  $TZ$ . Thus is the Door  $rr, tt$ , drawn, and the Posts are easily added, as before.

To exhibit the *Scenography* of Windows in a Wall: When you know how to represent Doors, you'll find no Difficulty in adding Windows; all that is here further required, being to set off the Height of the Window from the Bottom of the Ground. The whole Operation is as follows: 1. From  $1$  to  $2$ , set off the Thickness of the Wall at the Window; from  $3$  to  $4$ , its Distance from the Angle  $3$ ; and from  $4$  to  $5$ , its Breadth. 2. From



2. From 4 to 5, to the Point of Distance L, draw the right Lines E 5 and L 4, which will give the Perspective Breadth 10, 9 of the Window.  
 3. From 10 and 9 raise Lines perpendicular to the Pavement; *i. e.* draw the parallel Lines 6, 3.  
 4. From 3 to 11 set off the Distance of the Window from the Pavement 3, 11; and from 11 to 12, its Height 11, 12. Lastly, From 11 and 12, to the principal Point V, draw Lines V 11 and V 12, which intersecting the Perpendiculars 10, 13, and 9, 14, in 13 and 14, as also in 15 and 16, will exhibit the Appearances of the Window.

From these Examples, which are all no more than Applications of the first grand General Rule, it will be easily perceived what Method to take to delineate any other thing, and at any Height from the Pavement.

**SCENOGRAPHICK Projection**, or Perspective, is the Transcription of any given Magnitude into a Plane which intersects the Optick Pyramid at a proper Distance: For in Projection, there is to be consider'd, 1. The *Object*, or Foundation, or Ground of the Projection, from whence the *Pyramid*, *Cone*, or *Pencil of Rays* go. 2. The *Eye* of the Spectator, and, 3. The *Plane Table*, or *Diaphanum*, which intersects the Rays, somewhere between the Object and the Eye; and the Representation or Appearance of the Object in that *Plane*, is the *Projection*, or *Perspective* of the Object. This *Plane* is always supposed to be at right Angles with the Horizon. And from hence it will follow, that, 1. A *Point* will be projected there in the Diaphanous Plane where the Optick Ray cuts it. 2. That right Line will be projected where the Optick Triangle and the Plane do mutually intersect each other. 3. That a *Plane*, or *Superficies*, will be represented where the *Diaphanous Plane* cuts the Optick Pyramid of Rays coming from that Surface; and that Representation of it, called its *Image*.

**SCEPPE**, an old Word, omitted in our Glossaries, signifying a *Busbel*.

**SCEPTICK**, is the Term for a Person who maintains there is nothing Certain, and no real Knowledge at all to be had; but that a Man ought to Doubt of, and Disbelieve every thing.

**SCEPTICISM**, the Doctrine and Opinion of the Scepticks.

**SCEPTRUM**, in *Astronomy*, is one of the six new Constellations of the Southern Hemisphere, consisting of seventeen Stars, one of the fourth Magnitude, eight of the fifth, and as many of the sixth.

**SCHAR-PENNY**, *Scharn-Penny*, and sometimes *Schorp-Penny*. It appears from our old Books, that formerly some Customary Tenants were obliged to pen up their Cattle at Night in the Pound or Yard of their Lord, for the Benefit of their Dung, or *Scearn*, as is the *Saxon* Word. And if they did not do this, they were obliged to pay a small Compensation; which therefore was called by this Name of *Scharn-penny*, that is *Muck-penny*, or *Dung-penny*.

**SCHEAM**, or *Skeen*, in Architecture, is the Workmens Word for the middle Part of an Elliptical Arch.

**SCHEAT**, }  
**SEAT**, } in *Astronomy*, a fixed Star of the second Magnitude in the Juncture of the Leg with the Left Shoulder of *Pegasus*. Its Longitude, ac-

cording to Mr. *Flamsteed*, is  $25^{\circ} 21' 13''$ ; its Latitude  $31^{\circ} 8' 6''$  North.

**SCHEME**, is the Representation of any Geometrical or Astronomical Figure or Problem, by Lines sensible to the Eye; and these are otherwise called *Diagrams*.

**SCETICA febris**, is opposed to the Hectick Fever, because it is seated mostly in the Blood, and is easily cured; but the Hectick Fever is fixed in the very Habit of the Body, and not to be remov'd without great Difficulty. *Blanchard*.

**SCHIRE-MOTE**, was anciently a solemn Meeting of all the Free Tenants and Knights in any County, to do Fealty to the King, and elect an annual Sheriff. See *Folk-mote*.

**SCHIRE-WYTE**, was an annual Tax or Imposition, paid to the Sheriff of any County, or Shire, for holding the Assizes, or County-Courts.

**SCHIRRUS**, and *Schirroma*, is a hard, livid Swelling, that resists the Touch, and is without Pain. *Blanchard*.

**SCHOLIUM**, is a Remark made leisurely, and as it were by the by, on that Proposition, Subject, or Discourse before advanced, treated of, or delivered.

**SCIATICA**, the Gout in or about the Hip-Bone.

**SCIENCE**, is Knowledge founded upon, or acquir'd by clear, certain, and self-evident Principles.

**SCIOGRAPHY**, is the Art of *Shadows* or *Dialling*: Also in Architecture, this Word is sometimes taken for the Draught of a Building cut in its Length or Breadth, to shew the Inside of it; as also the Thickness of the Walls, Vaults, Floors, Timber-works, &c.

**SCIOPTRICKS**. See *Obscura Camera*:

**SCIOTHERICUM Telescopium**, is an horizontal Dial, with a Telescope adapted for observing the true Time both by Day and Night, to regulate and adjust Pendulum-Clocks, Watches, and other Time-keepers; invented by the ingenious Mr. *Molyneux*, who hath published a Book with this Title, which contains an accurate Description of this Instrument, and all its Uses and Applications.

**SCIRE facias**, is a Writ Judicial, most commonly to call a Man to shew Cause to the Court whence it issues, why Execution of a Judgment pass'd, should not be made out. This Writ is not granted until a Year and a Day be elapsed after a Judgment given. *Scire facias*, upon a Fine, lies not but within the same time after the Fine levied, otherwise it is the same with the Writ of *Habere facias seisinam*.

**SCLEROPHTHALMY**, it is a hard Blearedness of the Eyes, accompanied with Pain; a slow Motion of the Eyes, with Redness and Dryness. *Blanchard*.

**SCLEROTICA**, or hardening Medicines, are such as unite the Parts more firmly amongst themselves; and that either by dissipating the thin and soft Parts, or else sometimes by retaining them; the first by hardning the Matter into a *Schirrus* by too hot Medicines; the latter is done when the Part affected acquires a Hardness, by cooling and astringent Medicines, such are *Sengreen*, *Nightshade*, *Purslane*, and *Water-Lentils*. Therefore these *Sclerotick* Medicines are either healing, or else cooling and astringent. *Blanchard*.

**SCLEROTICA Tunica**. See *Cornea*.

SCO-



**SCOLIASIS**, is a Distortion of the Back-Bone to one or t'other side.

**SCLOOPOMACHÆRION**, is a Chirurgeon's Knife, with which Wounds of the *Thorax* are widen'd; 'tis used also in opening larger Swellings; as also in opening the *Abdomen*.

**SCONCES**, are small *Forts* built for Defence of some Pass, River, or other Place.

Sometimes they are made regular of four, five, or six Bastions; others of smaller Dimensions fit for Passes, or Rivers, and likewise for the Field, which are,

1. *Triangles with half Bastions*, which may be all of equal Sides, or they may be something unequal. However it be, divide the Sides of the Triangle into two equal Parts, one of these three Parts will set off the *Capitals* and the *Gorges*; and the *Flanks* being at Right-Angles with the Sides, make half of the *Gorge*.

2. *Square with half Bastions*, whose Sides may be betwixt 100 and 200 Feet; and let one third of the Side set off the *Capital* and the *Gorges*; but the Flank (which raise at right Angles to the Side) must be but one half of the *Gorge*, or *Capital*, that is on the sixth Part of the Side of the Square.

3. *Square with half Bastions and Tong*.

4. *Long Squares*.

5. *Star Redoubt of four Points*.

6. *Star Redoubt of five or six Points*.

7. *Plain Redoubts*, which are either small or great: The small are fit for Courts of Guards in the Trenches, and may be a Square of 20 Feet to 30. The middle Sorts of *Redoubts* may have their Sides from 30 to 50 Feet; the great Ones from 60 to 80 Feet Square.

The Profile (that is, the Thickness and Height of the Breast-works) to be set on these several Works, and the Ditches, are alterable and uncertain; for sometimes they are used in Approaches, and then the Wideness of the Breast-work at the Bottom may be 7 or 8 Feet, inward Height 6, and outward 5 Feet; the Ditch may be 8 or 10 Feet, and sometimes 12; and for the Slopes to be wrought according to the nature of the Earth, sometimes they may be made 14 or 20 Feet wide at the Bottom, and the Height of 7, 8, or 9 Feet, and to have two or three Ascents to rise to the *Parapet*; the Ditch may be 16 or 24 Feet wide, and 5 or 6 deep; and sometimes they may come near the smallest Sort of Ramparts, and have a Breast-work, Cannon Proof, with a Ditch of 50 or 60 Feet wide, and are thus made to set upon Passes or Rivers to endure.

**SCOPER-Holes**, in a Ship, are Holes made through the Sides, close to the Deck, to carry off the Water that comes from the Pump, or any other way. These Holes in the lowest Deck, and in the *Manniger*, have round Leathers nail'd over them, to keep the Sea-water from coming up into the Ship; which are called *Scoper-Leathers*; and the short Nails with broad Heads, which fasten these Leathers down, are called *Scoper-Nails*.

**SCORBUTUS**, the *Scurvy*, is a Disease that is Epidemical to the *Hollanders*: The Symptoms of it are generally livid Spots on the Hands and Feet, Weakness of the Legs, stinking Breath, Looseness of the Teeth, Bleeding of the Gums, Convulsions, Pains, running Gout, Cholick, &c. *Blanchard*.

**SCORE**; in *Musick*, is the Original Draught of the whole Composition, wherein the several Parts,

*viz.* Treble, second Treble, Base, &c. are distinctly scored or marked.

**SCORIA**, the Recrement, or Drofs of any Metal, that remains after it has been melted or refined.

**SCORPIO**, is the eighth Sign of the *Zodiack*, being usually marked thus (♏).

**SCOT**, a Part or Portion, according to *Rassall*, is a certain Custom, or common Tallage made to the use of the Sheriff, or his Bailiffs; but now signifies a customary Contribution laid upon all Subjects, according to their Ability; for whoever are assessed to any Contribution, are generally said to pay *Scot* and *Lot*.

**SCOTIA**, a Term in Architecture, the same with *Trochile*; which see.

**SCOTIA**, in Architecture, is a certain Member hollowed in Form of a Demi-channel, which is placed between the *Forus* and the *Astragal* in the Bases of Pillars; as also sometimes under the *Larmier*, or *Drip*, in the Cornice of the *Dorick* Order.

**SCOTOMY**, Dizziness or Swimming of the Head, is when the animal Spirits are so whirl'd about, that the external Objects seem to run round. *Blanchard*.

**SCRATCH-work**, in *Italian*, *Sgraffiti*, was a way of Painting in *Fresco*, by preparing of a black Ground, on which was placed a white Plaster; and this White being taken off with an Iron Bodkin, the Black appears through the Holes, and serves for Shadows: This kind of Work is lasting, but being very rough, is unpleasant to the Sight. 'Twas used in *Rome* by *Polidora de Caravaggio*.

**SCREW**, ? See *Cochlea*.

**SCRUE**, S

**SCRIBING**, when the Joiners would fit a Piece of Board, &c. to an irregular Surface, or any other irregular Piece, they open their stiff Iron Compasses to the greatest Distance, any where between the two Boards, &c. and then carrying one Leg along all the irregular Indentings, &c. of one, the other Leg moving parallel to it, describes that irregular Figure on the other Board; which being in that manner cut, will fit and join.

**SCROBICULUS Cordis**, or *Anticardium*, the Heart Pit, formerly called *Cardia*, the Pit of the Breast, or as 'tis usually called the Stomach.

**SCROPHULA**, are preternatural hard Glandules, or preternatural Swellings of the Glandules of the Neck and Ears; they are contain'd in a proper Tunick. *Blanchard*.

**SCROTUM**, is that Rag which contains the Testicles of the Male: It consists of a Skin, a fleshy Panniculus, and the two Tunics; of which, the outermost is called *Elytroides* or *Vaginalis*; the innermost Tunic is called *Albuginea*. In the middle of it is a Line extended in the Length, which divides the right Part from the left, which they call the *Septum*. For its more easy Distention or Contraction, 'tis generally supposed to be void of Fat. See more under the Word *Testes* and *Testiculi*.

**SCROTUM Cordis**, so some are pleased to call the *Pericardium*; which see.

**SCROWLS**, or *Volutes*, a Term in Architecture. See *Voluta*.

**SCRUPLES**, in *Astronomy*, as Scruples eclipsed are that Part of the Moon's Diameter which enters the Shadow, expressed in the same Measure, wherein the apparent Diameter of the Moon is expressed.



**SCRUPLES** of *half Duration*, in *Astronomy*, are an Arch of the Moon's Orbit, which the Centre of the Moon describes from the beginning of an Eclipse to its middle.

**SCRUPLES** of *Immerſion*, in *Astronomy*, are an Arch of the Moon's Orbit, which her Centre describes from the beginning of the Eclipse to the Time when its Centre falls into the Shadow.

**SCRUPLES** of *Immerſion*, in *Astronomy*, are an Arch of the Moon's Orbit, that is described by her Centre, in the Time from the Emerſion of her Limb to the End of the Eclipse.

**SCRUPLE**, a *Weight*, the third Part of a Dram, or twenty Grains.

**SCULPTURE**, may be diſtinguiſhed into three ſeveral Arts, each of which hath its Specifick Difference. For (ſaith Mr. *Evelin* in his *History of Chalcography*) beſides *Sculptura*, as it relates to *Chalcography*, there is both *Sculptura* and *Cœlatura*; both which, according to *Quintilian*, differ from the *fiſt*, with reſpect to the *Matter*, on or out of which any thing is wrought. For it was applied to cutting or carving in *Wood* or *Ivory*; and then was called *Tomice*, and the Artiſts *Deſectores*; to working in *Plaster*, and then called *Paradiſgrammaticæ*, and the Artiſts *Gypſochi*; to cutting or carving in *Stone*, and then called *Colaptice*; and the Workmen *Lithoxoi*; and laſtly, in *Metals*, *Glyphice*. And it may be deſcribed to be an *Art*, which teaches us to cut or take away all that is ſuperfluous of the ſubject *Matter*, reducing it to that *Form* or *Body* which was deſigned in the *Mind* of the *Artiſt*.

**SCURVY**. See *Scorbutus*.

**SCUTAGE**; all Tenants who held from the King by Military Service, were either bound to attend Perſonally in Wars and Expeditions, or for Default of ſuch Service, to pay a *Scutage* or Composition in Money, which was levied on every *Scutum Militare*, or Knight's Fee, and the Proportional Parts for the King's Uſe. And the Barons and Knights, which then paid a *Scutage* to the King, had a Power to levy the ſame Tax on thoſe Tenants who held from them in Military Service.

**SCUTAGIO habendo**, was a Writ that lay for the King, or other Lord, againſt the Tenant that held by Knight's-Service, to ſerve by himſelf, or elſe to ſend a ſufficient Man in his Place.

**SCUPPER-Nails**. See *Scoper-Holes*.

**SCUTIFORME Os**. See *Mola Genu*.

**SCUTIFORMIS Cartilago**. See *Enſiformis*.

**SCUTTLES** in a Ship, are ſquare Holes, big enough to let in the Body of a Man, cut in the Deck, to let People down on occaſion into any Room below. They are generally before the Main-Maſt, before the Knight in the Fore-Caſtle: In the Gun-Room to go down to the Stern Sheets: In the Round-Houſe to go down into the Captain's Cabin, when forc'd by the Enemy in a Fight aloft. There are alſo ſome ſmaller Scuttles, which have Gratings over them; and all of them have Covers to them, that Men may not tumble in at Night, when 'tis dark.

Alſo thoſe little Windows, and long Holes, which are cut out in Cabbins to let in Light, are called *Scuttles*.

**SCUTUM**. See *Mola Genu*.

**SCYPHOS**, is the *Infundibulum* in the Brain; likewise thoſe Paſſages which convey the Spittle from the *Os Cribiforme* to the *Pallat*, are ſo called by ſome Writers. *Blanchard*.

**SCYRE-GEMOTE**, was anciently a Court held twice a Year (as the Sheriff's Turn is now) by the Biſhop of the Dioceſs and the *Ealderman*, i. e. in ſuch Shires as had *Ealdermen*, and by the Biſhops and Sheriffs, in ſuch as were committed to the Sheriffs that were immediate to the King; where both the Eccleſiaſtical and Temporal Laws were given in Charge to the Country.

**SCYTALA**, in *Mechanicks*, a kind of Radius, or Spoke, ſtanding out from the Axis of a Machine, as a Handle, or Lever, to turn it round, and work it by.

**SEA-Drags** are ſuch things as hang over Ships at Sea, as the Boat, &c. when it is towed.

**SEA-Gate**, when two Ships are aboard one another, by means of a Wave or Billow: The Seamen ſay, they lie aboard one another in a *Sea-Gate*.

**SEA-Quadrant**. See *Back-Staff*.

**SEA-Yoke**, when the Sea is ſo rough, that they cannot govern the Helm with their Hands, then the Seamen ſeize two Blocks to the end of the Helm, one on each ſide, and then reeving two ſmall Ropes through them, which they call Falls, and which are faſtned to the ſides of the Ship, by having ſome Men at each Tackle, they govern the Helm according to Direction. This they call a Yoke to ſteer by. Sometimes they make a Yoke, by taking a double Turn about the End of the Helm by a ſingle Rope, the Ends being laid to the Ship-ſides, and by this means they guide the Helm; but this is not ſo good a Yoke as the other.

**SEALER**, is an Officer in *Chancery*, appointed by the Lord Chancellor, or Keeper of the Great Seal, to ſeal the Writs and Inſtruments there made in his Preſence.

**SEAMS** of a Ship, are Places where her Planks meet and join together. There is alſo a kind of peculiar Seam in the ſowing of Sails, which they call a *Monks Seam*; which ſee.

**SEASONS**. Here occur two Difficulties: *Fiſt*, Whether the Seasons are to be defin'd from the Sun's Entrance into, and Stay in certain Signs of the Ecliptic; as *Aſtronomers* commonly do, beginning in the Spring when the Sun enters *Aries*; Summer when *Cancer*, &c. But theſe Definitions taken hence failing in South Latitude, for that they are forc'd to frame contrary Definitions, beginning Spring there when the Sun enters *Libra*, Summer when *Capricorn*, &c. But, 1. General Things ought to have general Definitions. 2. Theſe their Definitions, even ſo fram'd, have no Place in the *Torrid Zone*; for when the Sun is vertical to any Place, it is evident that it ought to be Summer there, in reſpect of the Heavens (if no Impediment intervene) which will not agree with theſe Definitions. 2. The ſecond Difficulty is, whether the four Seasons ought to be defin'd with reſpect to Heat and Cold, or to the Sun's approaching and retiring; the reaſon of which Diſtinction is, Heat and Cold not bearing Proportion to the Sun's Nearneſs or Remoteneſs in many Places of the *Torrid*, and in ſome of the *Temperate Zones*, but depending in a great Meaſure upon the Accidents of the Neighbourhood of high Mountains; whoſe Height exceedingly chills the Air brought by the Winds over them, and the Nature of the Soil, which variously retains the Heat, particularly the Sandy, which in *Africa*, *Arabia*, &c. makes the Summer's Heat incredible to thoſe who have not felt it; therefore the Seasons may not improperly be divided into the *Celeſtial* and *Terreſtrial*, in which reſpect the *Terreſtrial* Summer of a Place is the hotteſt of the four

Sea-



Seasons, the Celestial that of the four in which the Sun is nearest, Winter being the contrary, and accordingly of the rest. According to which Notions, the (Celestial) Summer of any Place is that Season of the Year, whose beginning is that Day in which the Sun hath the least Meridian Distance from the Zenith of that Place, (and that the first time, if the Sun is twice in a Year Vertical to that Place) but the End, that Day in which the Sun hath a mean Meridian Distance from the Zenith of that Place. 2. Winter, whose Beginning is that Day in which the Sun hath the greatest Meridian Distance from the Zenith of that Place; and whose End, when a mean Distance. 3. Spring, from the End of Winter to the Beginning of Summer. 4. Autumn, from the End of Summer to the Beginning of Winter. According to these Definitions the (Celestial) Summer of those Places of the Earth which lie between the Tropick of Cancer, and the North Pole, begins when the Sun enters the first Degree of Cancer (*June* the 10th) and ends when the Sun enters into the first Degree of Libra (*September* 11th) and at the same time in all these Places, so it is Autumn to these Places while the Sun passes from the Beginning of Libra to the Beginning of Capricorn (from *September* the 11th to *December* the 10th) Winter beginning then, ends when the Sun enters Aries (*March* the 11th) between which and Summer falls the Spring.

To all Places between the Tropic of Capricorn and the South Pole, their Summer is during our Winter, their Autumn during our Spring, &c.

The Torrid Zone is divided into these Parts that lie under the Line, those on the North Side, and those on the South Side. Those Places which lie under the Equator, have this peculiar to them, that they have two Summers, two Winters, two Springs, and two Autumns. Each Year their first Summer is while the Sun moves from the first Degree of Aries to the second Degree of Taurus (from *March* the 11th to *April* the 12th) Autumn, thence to the first Degree of Cancer (*June* the 11th) Winter, thence to the twenty-eighth Degree of Leo (*August* the 9th) Spring, thence to the first Degree of Libra (*March* the 11th.) Their second Summer, thence to *October* the 12th; their second Autumn ends *December* the 11th. Their second Winter, *February* the 9th. Their second Spring, *March* 11.

All Places on the North Side of the Torrid Zone end Autumn, and begin Winter, at one and the same Time, viz. *December* the 11th, the Sun having then the greatest Meridian Distance, according to the foregoing Definitions; but they do not begin and end Summer and Spring, nor begin Autumn at one and the same, but at different Times; for their Summer beginning when ever the Sun in returning from the first Degree of Capricorn, becomes Vertical to them, which is at different Times, according to their different Latitudes; their Summer, I say, beginning then, must commence at different Times in different Latitudes; the End likewise of Summer, and Beginning of Autumn, is also the End of Winter and Beginning of Spring, which will be at different Places in different Times, because in different Latitudes the Sun will at different Times obtain a middle Meridian Distance from the Zenith of the Place.

The Case is the same on the South Side of the Torrid Zone, allowing only for the Difference of North and South Latitude.

In the Temperate and Frigid Zones, the four Seasons are nearly equal; in the Torrid Zone, they

are not only unequal to one another, but the same Season is of different Lengths in different Latitudes.

What hath been already said, is to be understood of the Celestial Seasons, i.e. as they depend merely upon a Celestial Cause, viz: the greater or less Meridian Distance of the Sun, and may easily be understood by applying the Definitions to particular Cases; but that Light, Heat, Cold, &c. do not solely depend upon this Cause, will be shewn by what follows.

In the Torrid Zone, as the Sun by Day is nearly Vertical, and raised to the greatest Height above their Horizon, so by Night he is depressed the lowest he can be beneath their Horizon, at the greatest Distance from their Zenith; so that these Places fall in the Middle of the Earth's Shadow, and so have the least Benefit of the Sun's Rays reflected in the Air, and consequently have the least and shortest Twilight. In the Frigid Zones, as the Sun is never by Day raised to any great Height above, so neither by Night is he depressed much beneath the Horizon; so that there the Air is most enlighten'd by the Sun's reflected Rays in his Absence, and they enjoy the longest and greatest Twilight; the Temperate Zones, as in other things, so in this, enjoying the Mean between the two Extreams.

In many Places of the Torrid Zone, as in the *Indian* Islands, *India* itself, the Procurrent Tract, or Tongue of *Africa*, *Guinea*, and *Mexico*, the Earth being sulphureous, emits warm Steams; in other Places it is sandy, as in *Lybia*, *Negro-Land*, &c. Part of *Arabia*, *Peru*, and between *Peru* and *Brazil*; whence in these Places the Sun's Heat becomes excessive, being long retain'd, and strongly reflected by the Sands; other Places, as *Abassia*, *Guinea*, *Congo*, *India*, *Brazil*, abound with Rivers, whence most Vapours are raised, which much rebate the Force of the Sun's Rays, and render his Heat tolerable; but the sandy Parts of the Torrid Zone have few Rivers.

Most Places of the Torrid Zone are near the Sea; as *India*, the Tongue of *Africa*, *Guinea*, *Brazil*, *Peru*, *Mexico*; few Parts of the Torrid Zone are Inland, as the inner Parts of *Africa*, and the Countries between *Peru* and *Brazil*, whence in these Places the Heat and Drought is great.

Most Parts of the Torrid Zone, as they are generally almost surrounded by the Sea, have in the inland Parts greater or less Ridges of Mountains, as *India*, the *Indian* Islands, the Tongue of *Africa* and *Peru*, which much diversify the Light, Heat and Weather of these Places; for in some Places they obstruct the Eastern, in some the Western Rays of the Sun; and moist Vapours carried thither by the Wind, are condens'd by their Cold at their Tops. Hence Clouds, Rains, Meteors, &c. by which the Light and Heat of the Sun is much obstructed, and the Order of the Seasons depending on his greater or less Distance, much disturb'd, few Places of the Torrid Zone want Ridges of Mountains, as inner *Africa* and *Mexico*.

The Trade Wind and Monsoons, &c. according as they blow upon a Place from Sea or Land, from a hotter or a colder, from a moister or a drier Place, do much diversify the Seasons of the Year, as likewise do the Rains which fall at set Times of the Year in several Parts of the Torrid Zone.

The four Seasons depending upon the foregoing Terrestrial Causes, are in the several Parts of the Torrid Zone as follow: But first it is to be premised,



fed, that Winter in the Torrid Zone is not attended with Frost and Cold, but rather with Rains, and a less Degree of Heat than the Summer. Secondly, That in most Places of the Torrid Zone are not reckon'd four, only two Seasons of the Year, *viz.* Winter and Summer, and these are not distinguished by Heat and Cold, but by the Driness or Moistness of the Season. We will begin at that Part of *Africa* which lies in the Torrid Zone, going Eastward, and ending at *Brazil*.

The Western Coast of *Africa*, from the North Tropic to Cape *Verde*, is fruitful of Corn, Fruits, and Cattle; the Inhabitants strong, and the Air so temperate, that the Inhabitants go naked, except the Rich among them, who cover themselves with Cloth. This Fruitfulness of Soil and Temperateness, contrary to what is common in the Torrid Zone, is caused from its many Rivers, especially *Senegall* and *Gambia*, and from the moist Vapours of the neighbouring Ocean, and its Sea-Breezes; but how the Seasons of the Year are here, I have not met with in any Author.

The Western Coast of *Africa*, from Cape *Verde* in 2 Degr. South Lat. taking in the Upper or Proper *Guinea*, is affected with an uninterrupted Heat; however, about *Sierra Leona*, as also in other Parts of this Coast they reckon *March, April, May, June, July*, Winter, especially *April, May* and *June*, because during them there are frequent, and almost continued warm Rains, frequent Thunder and Lightning, sudden Gusts from all Points of the Compass, called Tornados, by the *Portuguese* Travados, and unwholesome foggy Easterly Winds, called Hermitan by the Natives. This Season being over, they sow the Earth. Their Winter then is during *April, May, June*; Spring, during *July, August, September*; Summer, *October, November, December*; Autumn, *January, February, March*. This Order of the Seasons differs much from the Celestial; for during *May, June*, and *July*, the Sun being nearly Vertical, the Heat ought then to be greatest; on the other Hand, *October, November* and *December* ought to be Winter, if we only regard the Sun, which has then the greatest Meridian Distance from them; but it is otherwise. The Cause of these Rains and Storms, attended with Thunder, when the Sun is nearly Vertical, seems to be the Sun's drawing in the Day-time many Vapours from the neighbouring Sea, and sulphureous Steams from the Land (*Guinea* abounding with Sulphur and Metals) which Vapours are by the Cold of the Night condens'd into Rain, especially when there is no settled Wind in these Parts which may disperse them, Calms being here most frequent; and these Rains, during whose fall they call it Winter, are not cold, but warm, Wind seldom blowing, and the Sun being Vertical; nay, the Heat is so stifling, as to cause a great Difficulty of Breathing; which Heat, join'd to the Moisture of the Air, is so great as to corrupt fresh Fish kept undress'd for half a Day. When the Wind blows true upon this Coast, it always blows South-westerly. But tho' the Fields are without Corn, yet the Trees flourish and bear Fruit during this rainy Season.

Of the inland Parts of *Africa*, within the North Tropic, we only know that they are barren, except on the Banks of the *Niger*; which overflowing yearly in *June, July* and *August*, renders the Ground very fruitful, and makes many Lakes. The rest is parch'd with great Heat, being mostly plain, sandy, and without Rivers: Here we

have no Account of rainy Months, like those in *Guinea*.

Along the Western Coast of *Africa*, from 2 Deg. South Lat. to the South Tropic, taking in *Congo, Angola, &c.* the Temperature of the Air in Winter is like that of the Spring about *Rome*; and the Heat is so even and moderate all the Year, that they never change their Cloaths, nor are the Tops of the neighbouring Mountains very cold. Their rainy Winter is from about *March 5*, to *September 5*, in which Time the Sun is seldom seen; Travados being likewise frequent; but it rains not whole Days, but generally two Hours before, and two Hours after Noon, great Drops, which are presently drank up by the Earth. From *September 5*, to about *March 5*, they reckon Summer, in which Time it seldom or never rains, but is always serene. To produce these Rains, and sort of Winter in these Parts during these Months, conspire two Causes, *viz.* the Sun's greater Meridian Distance, and the Ridge of the Mountains stretching Eastward of these Maritime Parts, which are seen continually clouded during these rainy Months; for the Sun raising many Vapours out of the Ocean thereabouts, a North-westerly Monsoon, which blows there during these Months, carries the Vapours to this Ridge of Mountains, where through the Cold, they are condens'd, and turn'd into Rain; whence comes the Inundation of the *Nile*, and other *African* Rivers; those of the Kingdom of *Congo*, particularly during these rainy Months, overflowing it to such a Degree, as to make it vie with *Egypt* for Fruitfulness.

In the Kingdom of *Loango*, bordering upon *Congo*, the rainy Months are not the same with those of *Congo*; but are *January, February, March* and *April*; *January* and *February* being fair in *Congo*, which is certainly to be attributed to a different Situation of some Mountains, and a different Monsoon.

The Isles of *St. Thomas* (under the Equator) and of *Anobon* (distant one Degree and a half from the Equator) are very fruitful of Sugar, Corn, and Fruits, especially Citrons and Oranges. The rest of the Coast to the South Tropic we are ignorant of; leaving therefore the Western Coast, and doubling the Cape of *Good-Hope*, we return to the South Tropic, and come to the Eastern Coast of *Africa*; in which lie *Sofala, Mozambique* and *Zanguebar* to the Line; along which Coast, their Winter, or rainy Season, is from *September* to *January* inclusive, the rest being fair, which is contrary to the Seasons in *Congo*, lying on the same side of the Equator; of which Difference, that Ridge of Mountains which runs North and South, and divides the Tongue of *Africa* nearly in the Middle, is the Cause. This Country is but moderately fruitful, being in many Places sandy and barren, and excessive hot; but the Rivers, neighbouring Sea, and Easterly Trade-wind, in most Places moderate the Heat.

Of the rest of the Eastern *African* Coast, from the Line to the North Tropic; and of the inland Parts of the *Abassins*, we have little or no Knowledge.

Leaving *Africa*, we come into those Parts of *Asia* which lie in the Torrid Zone, where the *Arabian* Coast upon the *Red-Sea* offers it self first, having Mountains to the Eastward, and the Sea to the Westward. The Heats of these Parts are so excessive from *March* to *August* (which agrees with their Celestial Summer) that the Rich have cold Water continually pour'd upon them by Days, or lie in Vessels full of Water. The Merchants



in *Aden* meet and do Business by Night; which great Heat is caus'd through the Want of watry Vapours, the Continent to the Eastward being stony, and having very few, and very small Rivers, and the constant Easterly Wind blowing the Vapours rais'd from the *Red-Sea* off from their Coast. Beside, the Soil is sandy, which retains and reflects the Heat strongly.

In *Cambaya*, which lies in *India* nearly under the North Tropic, as also on the Coast of *Malabar*, the rainy Season is from the Middle of *June* to the Middle of *September*. But not in all these Places equally, it raining more in the Provinces about *Goa* and *Cochin*, less in *Cambaya*; but at *Goa* in *April* and *May* begin more moderate Rains, with Storms and Thunder. In these rainy Seasons, Storms and Thunder are frequent upon the Coast; so that then all Navigation ceases there, and the Rivers overflow; but in *September* the Sea is open'd. But the Rains are not fierce in these Parts, except when Storms happen; but ceasing several Hours in the Day, gives them Time to sow and plant, for which they choose this Season, contrary to the Practice in *Guinea*. The Heat of the Weather during these Rains is temperate. The Fruitfulness of the Earth proceeding from these Rains, is incredible. If these Rains do not fall any Year, which however very seldom happens, as in the Year 1630, the Hopes of Harvest and Seed-time are taken away; thence dearth of Provisions, scorching Heats, burning Fevers, Pestilence, and great Mortality. It is very happy for these Countries, that the Rains fall when the Sun is Vertical to them, otherwise their sandy Soil would be render'd barren, like *Arabia* and *Lybia*.

In the Eastern Coast of *India*, call'd *Coromandel*, the Terrestrial Seasons differ from the Celestial. The Natives divide the Year into three Seasons, the Hot, the Rainy, and the Cold. The Hot is during *March*, *April*, *May* and *June*; especially from the Middle of *May* to the Middle of *June*, when the North Wind meets your Face hot as if it came from an Oven; the Stones and Sand retaining an incredible Heat, and no Showers cooling the Air. But the Water in the Wells is so cold, that many drinking too greedily of it, because of the great Heat, die suddenly. The rainy Season is during *July*, *August*, *September*, and *October*; the Cold during *November*, *December*, *January*, and *February*. During *December* and *January*, the Cold, especially by Night, is pretty sensible. What is in this very remarkable is, that the Seasons of *Coromandel* and *Malabar* should differ so much, being both in one Climate, in some Places but seventy, in others but twenty Miles asunder; so that in one Day you may travel from a clear Air, and hot Summer, to a rainy and stormy Winter. But this however is not singular to these Parts, and is caus'd by a Ridge of Mountains running North and South, and dividing *Coromandel* from *Malabar*, and by the Trade-winds and Monsoons: For on the Coast of *Coromandel* the general Easterly Trade-winds blows mostly (*May* and *June* excepted) which carries the Vapours toward the Mountains, where being condens'd by the Cold, they fall in Rains on *Malabar*; but the shifting of the Wind does, for the like Reason, bring Rains to *Coromandel*, and fair Weather to *Malabar*.

In *Siam*, *Pegu*, and *Malacca* the Rains fall in *September*, *October* and *November*: But in *Malacca* it rains twice or thrice every Week, except in *January*,

*February*, and *March*, during which the Sky is continually serene. These things happen all contrary to Celestial Causes, and proceed from the Situation of Mountains, the periodical Winds, and the neighbouring Sea. The Fruitfulness of these Countries is chiefly caus'd by the overflowing of the Rivers, the Vapours of the neighbouring Sea and the Rivers temper the Air, and the Winds are periodical; thence there is great Plenty, and pleasant living here. In the Kingdom of *Patana*, and its Neighbourhood, Summer begins with *February*, and ends with *October*, the Easterly Trade-wind reigning here, and the Air being healthy. During *November*, *December*, and *January*, are continued Rains, which however hinder them not from enjoying new Fruit every Month. The same is to be understood of *Cambaya*. This Winter agrees with the Celestial.

Leaving *Asia*, we cross the Pacific Sea, to that Part of *America* which lies within the Torrid Zone, which is two-fold, the Southern and the Northern: The Southern is divided into *Peru* and *Brasil*. The *Peruvian* Provinces, tho' near one another, enjoy different Seasons at the same time; for *Peru* is divided into the Sea-coast, the mountainous, and the plain Part behind the Mountains, all lying in the same Climate. In the mountainous Parts, the Rains fall almost continually from *October* to the End of *March*, when they ought to enjoy Summer from the Sun's Neighbourhood. But during their Summer, from *April* to *October*, falls no Rain. Along the Sea-Coast of *Peru*, is hardly any Winter all the Year, for it never rains there; but from *April* to *October* is reckon'd their Winter, the Sun having then the greatest Meridian Distance, and being always over-cast, the Air during these Months being perpetually cloudy, but no Rain, only a Dew follows, and that chiefly during *June*, *July*, and *August*, each Day before Noon; but this Weather is not unhealthful. During this Season, in the mountainous Parts, the Weather is clear. The Sea-Coast of *Peru* is divided into very fruitful Valleys, and barren, sandy Deserts scatter'd between. In the neighbouring Islands it never rains, a Dew only falling. In the Island *Gorgona*, in three Deg. North-Latitude, it rains eight Months almost continually, with excessive Storms and Thunder; but during *May*, *June*, *July*, and *August*, is their Summer, and fair Weather, tho' the Sun is then at the greatest Distance from them. In some Places of this Part of the Torrid Zone, the Cold is remarkable; for in the Country of *Popayan*, Province of *Pastoa*, and Valley of *Arisina*, the Cold is so great, that Corn will not grow there either in Summer or Winter. And in the Country about the City *Cusco*, almost Mid-way between the Equator and South Tropic, Snows fall, and Ice freezes to a considerable Thickness. Whence it may be concluded, that no Part of *Peru* is any Part of the Year intemperately hot, except the Sands and the Hills; but the Valleys are very fruitful and pleasant, with Variety of Trees and Corn: They are water'd during their Winter by a daily Dew, of which above; and in the Summer by the Torrents from the Mountains, it being at that time Winter, and the rainy Season in the mountainous Parts. The Cause of this Diversity proceeds, 1. From the Mountains. 2. From the South-westerly Wind, which blows always in *Peru*; which carries the Vapours to the Mountains, where they are condens'd, and fall in Rain. In the Maritime Parts of *Peru* are no Springs.



*Brasil*, stretching from about 2 Deg. to 24 Deg. South Latitude, is extraordinary pleasant and healthful, thro' so excellent a Temperature of the Air, as gives to that what it does to no other Part of the Earth: Of which, thus *Piso* in his Book of *Brasilian Medicines*: In the Maritime Part thereof blows a gentle cherishing Easterly Wind in the Morning, grateful to Man and Beast, and abating the intolerable Heat of the Vertical Sun; which Wind, toward the Sea-Coast, is perceived very early; in the inland Parts, later in the Morning: Nor languishes it about Evening, but encreases with the accompanying Sun; contrary to what is usual in most Parts of *India*; so that it often lasts beyond Midnight. Altho' the other side of this Country (which is at a great Distance from *Peru*, from which it is divided by a Ridge of vastly high Mountains) be infected late at Night by an unhealthful Westerly Wind, blowing from off the Continent, and over an infinite Number of Marshes; yet the Mountains in the Maritime Parts always screen the Sea-Coast from it, the Easterly Wind being there predominant.

As the Seasons of the Year differ here very little, so the Days and Nights are not more equal in Length than different in the Degrees of Heat and Cold; for the Sun rising to a great Meridian Height, after he has open'd the Pores both of the Earth and Men, is as deeply depress'd below their Horizon, whence the great Condensation of the Air makes the Night-Dew: Hence a Cold so piercing strikes Humane Bodies from the third Hour of the Night to near Sun-rise, that it uses to be very troublesome and unhealthful to Strangers. To prevent which, the *Brasilians* keep a Fire burning all Night near their Hammocks, which moderates the Cold of the Night, and keeps venomous Insects at a Distance.

The Cold is generally more intense in the Summer Nights than the Winter, when the Air is more calm and cloudy. Their rainy Season begins with *April*, and ends in *August*, which Month is tempestuous, but compos'd by the succeeding Spring. The inland Parts to the Westward, are colder than toward the Sea-Coast; so that sometimes Men's Hair hath been cover'd with a Hoar-Frost. When it is Summer, and fair Weather upon the Sea-Coast to the Eastward, it is Winter and rainy Weather to the inland and marshy Parts of *Brasil* beyond the Mountains.

The Sky is often cover'd from the East, Westward, with Clouds, which are very thin, except during the Rains. The Sky is on all sides so serene, especially about Evening, that the Moon is never obscur'd by Clouds or Mists, both new and old Moon being visible the same Day, and Writing may be easily read by the Moon's Light the first Quarter.

The Weather here, however, according to the different Aspects of the Planets, and lower Causes conspiring, is now and then intemperate. They have often Lightning here in the Evening without Thunder, though the Weather be very clear and dry.

The Drops of Rain are very large, and fall very violently; a stifling Heat sometimes going before, sometimes following. The Dew here is more impregnated with Nitre than the *European*; more fruitful, and more piercing, which is evident in all Metals, especially Iron, which it presently rusts in the clearest Weather. So far *Piso*.

The whole Country of *Brasil* rises gently into pleasant Hills; high Mountains are none toward the Sea-Coast; some, however, are seen at a Distance in the Desert Parts, within the Land, among the parched Hills, not every where, but at the Distance of some Miles, are scatter'd Valleys water'd with small Rivulets, by which they are render'd fruitful, as well during the dry as rainy Season. The Hills, during the Summer Months, are so parched, and render'd so barren, that not only the Grass, but sometimes the very Trees perish. It seldom rains a Night and Day together without Interruption, and very rarely for several Days together. The rainy Months sometimes vary a little. In the Year 1640 (as *Mac-grave* observes) the rainy Months were seven, *February, March, April, May, June, July, August*; it raining almost without Interruption during *May* and *July*. In 1641, the same seven Months were rainy, but especially *April, May, and July*. In 1642, the rainy Months were six, *March, &c. August*. These Observations belong not to all *Brasil*, only to *Pernambuc*. The few Irregularities that happen in the Seasons of *Brasil*, contrary to Celestial Causes, are to be accounted for from the Situation of the Mountains, the Nature of the Soil, and the Winds.

In *Nicaragua* in *North America*, it rains six Months, *viz. May, &c. October*, the other six being hot and dry, so that Men are forc'd to travel by Night, though the Sun be then at the greatest Distance. The Mountains of *St. Martha*, in about 11 Deg. North, are for the most Part cover'd with Snow.

Whence it appears, 1. That in some Places is scarce any sensible Cold any time of the Year, their Winter being rather the Effect of Rain than Cold. 2. That in some Places the Cold is easily perceiv'd. 3. That in the Night-time, especially the latter Part, the Cold is pretty intense, because of the Sun's great Depression below the Horizon. 4. That the near Equality of the Night and Day is not the least Cause that the Heat is tolerable, and these Parts habitable; which would certainly be otherwise, were the Sun's stay as long above the Horizon here, as in the Temperate and Frigid Zones. 5. That the Winds do much diminish the Heat of the Sun. 6. That Places lying near one another, and in the same Climate, enjoy the one Winter, the other Summer at the same time. 7. That those Places, whose Winter and Summer, or wet and dry Seasons, do not keep Time with the Sun's greater or less Distance, lie Westward of high Ridges of Mountains, *Peru* excepted. 8. That the Seasons observe no one certain Rule in the different Parts of the Torrid Zone. 9. That although most Inhabitants of the Torrid Zone divide the Year only into two Seasons, as most Writers do, *viz. the wet and dry*, that it may nevertheless be not inconveniently divided into four, the Dry, into Spring and Summer; the Wet, into Autumn and Winter. 10. That in some Places is a continual Harvest, in some twice, in others once a Year.

Of the four Seasons of the Year in the Temperate Zones. In these Parts the Seasons are principally rul'd by the Sun's greater or less Distance, the above-mentioned Terrestrial Causes not being able here, as in the Torrid Zone, to invert the Order following therefrom; not but that the Nature of the Soil, Situation of the Mountains, and Distance of the Sea, &c. have very sensible Effects upon the Weather.



ther, though they are not able to turn Winter into Summer, &c. as between the Tropics.

Near the Tropics, the Summer's Heat is great for the most part; and in some Places they have their rainy Seasons, as between the Tropics; so that Part of *Guzurat*, that lies without the Tropic, hath almost the same rainy and dry Months, with that Part of it which lies within the Torrid Zone. But in the Temperate Zones, we distinguish Winter and Summer, not by rainy and fair Weather, but by Heat and Cold.

In *Ormus*, the Sea-Coast of *Persia* and *Arabia*, the Summer is dry and so hot, that both Men and Women sleep by Night in Troughs of Water.

Through all *Barbary*, according to *Leo Africanus*, the Moist and Cold begins about the Middle of *October*, the Cold encreasing a little, but not so much, as in the Morning to make a Fire car'd for. The Weather in *February* grows warm, but so inconstant, as to change five or six times a Day. The North and West Winds blow very strong in *March*, and cloath the Trees with Blossoms. Most Fruits are form'd in *April*, and Cherries are ripe in the beginning of *May*. In the middle of *May* they gather Figs, and about the middle of *June* ripe Grapes; but the greatest Plenty of Figs and Peaches is in *September*. They reckon their Spring from *February* the 15th to *May* the 18th, which three Months are always pleasant and temperate; their Summer to *August* the 16th, which is very hot and ferene; Autumn to *November* the 16th; then Winter to *February* the 15th, during the beginning whereof they plow their Champaign Country, but the Hilly Part in *October*; the End of Autumn, all Winter, and part of the Spring is stormy, with Hail, Lightning, and terrible Thundering. Their Corn receives much Damage from Snow, especially falling by Day, when the Corn is in Bloom.

In Mount *Atlas*, 7 Deg. without the North Tropic, they divide the Year into two Parts only, reckoning it Winter from *October* to *April*; but the Tops of the Mountains are always cover'd with much Snow.

In *Biledulgerid* they gather their Corn in *May*, Dates in *October*, and the Cold is intense from the middle of *September* to *January*. A dry *April* or *October* spoils the Husbandman's Hopes. *Leo* mentions many Mountains in *Africa* near the North Tropic cover'd with Snow.

Though the North Part of *China* be in the same Latitude with *Italy* (from 30 Deg. to 42 Deg.) yet *Trigantius* affirms the Cold to be much more intense there, so as to freeze very great Rivers and Lakes; to cause which, the snowy Mountains of *Tartary*, not far distant, may contribute.

In *New Albion*, in 42 Deg. North, the Latitude of *Italy*, Sir *Francis Drake* found it so cold in *June*, the Mountains being cover'd with Snow, that he was forc'd to go to the Southward. This Country is rocky.

In *Egypt*, bounded by the North Tropic, *January* and *February* are a temperate Spring (according to *Prosper Alpinus*, *Lib. 1. de Med. Egypt*;) Summer, thence to the End of *August*; Autumn, during *September* and *October*; and Winter, during *November* and *December*. About the Beginning of *April* they cut their Corn, and immediately thresh it; after *May* the 20th no Corn is seen in the Fields, no Fruit on the Trees. In the Beginning of *June* the *Nile* begins to overflow.

About the Straights of *Magellan*, though in our Latitude (52 Deg.) their Summer is so cold, that the *Dutch* found large Quantities of Ice in a certain Bay there in *January*, which ought to be their hottest Season, the Mountains toward the Sea-Coast being always snowy. And it is observ'd, that in most Places of the South Temperate Zone, the Cold is more intense, and the Rains more violent in Winter, and the Heat less in Summer than in most Parts of our Northern Temperate Zones, lying in the same Latitude, whatever may be the Cause thereof.

The Cold is so intense in a Valley about four Miles in Compass, near the City Imperial in *Chili*, and about 39 Deg. South Latitude, that nothing will grow there.

In the Kingdom of *Chili*, Spring begins with *August* (which is sooner than Celestial Causes require) and ends about the Middle of *November*; thence Summer to the Middle of *February*; thence Autumn to the Middle of *May*; when a rainy Winter begins, attended with Frost and Snow, which seldom lies many Days undissolv'd, by the Sun not appearing; but it seldom snows in the Valleys, though the Snow falling among the Mountains, fills the Openings between to the Height of their Tops, and lasts almost all the Year; when it dissolves there, it greatly swells the Rivers and Torrents, and renders the neighbouring Country wonderfully fruitful. But though it seldom snows in the Plain, the Cold exceeds that of most Parts of *Europe*; which is much encreas'd by piercing Winds, which are sometimes insupportable; whence the Sea-Coast is most temperate.

In *England*, the Winter's Cold is not so intense as upon the Continent of *Germany*. Between *Siberia* and *Tartary*, in the utmost Limits of our Temperate Zone, are pleasant Fields and Pastures, they having scarce any sensible Cold or Winter, where the *Muscovites* have built a City call'd *Toorn*, to stop the Inroads of the *Tartars*.

In *Japan* (from 31 Deg. to 39 Deg. South Latitude) the Winter is more cold, snowy and rainy, than other Countries of *Europe* and *Asia* in the same Climate; because *Japan* consists of many Islands separated by small Channels, and lying in the Middle of the Ocean. In *Armenia*, and the neighbouring Parts, the Summer's Heat is excessive in the Valleys among the Mountains; whence the Wealthier among them spend several Summer Months upon the Mountains.

The four Seasons, and Night and Day, are after the following manner in the Frigid Zone.

1. The Sun does not rise above the Horizon for several Days, or Months, according to the Places greater or less Distance from the Pole, and for an equal Time doth not set. 2. His Elevation above the Horizon is but very small in these Parts, so that he shines upon them with very oblique Rays. 3. He is by Night depressed but a little below their Horizon; and in Places near the Polar Circle, the upper Limb of the Sun rises several Days before his Centre, half of the Sun taking up the Space of fifteen Minutes in the Heavens; so that in the Latitude of 67 Deg. his upper Part will rise twenty-three Days before his Centre. But nearer the Pole, in 70 Deg. 75 Deg. &c. the Difference of Time between the rising of the upper Part and Centre is very small, not above a Day or two, the Declination of the Sun in those Parts of the Ecliptick, with which he rises in their Horizon, encreasing quickly.

From



From the small Depression of the Sun below their Horizon, they enjoy a long Twilight of several Hours, or Days, according to their Latitude, which is likewise encreas'd by the great Refraction of the Sun's Rays in the Air, which is here much condens'd by the Cold; which great Refraction likewise makes the Sun's Body visible to them several Hours, or Days, before and after he really rises and sets. 4. The Earth in these Parts is mostly stony, rocky, or hard like Stone, in few Places bituminous, clayey, fulphureous, or fat. Hence in these Parts is a moderate Fruitfulness, in those Barrenness. 5. These Parts border on the Sea, the inland Parts being yet undiscover'd. 6. Some few Parts of the Frigid Zones have Mountains of a tolerable Height, being mostly stretch'd out into vast Plains. 7. The Winds mostly blow from the cold Point, seldom Easterly or Westerly; but in the North Frigid Zone, from the North; in the South, from the South. 8. These Parts are much infected with Fogs and Rain.

Hence the Weather and Nature of the Season in these Parts may easily be gather'd: For in Winter, the Sun not rising for several Days, thick Fogs for the most Part, and uninterrupted Frost and Snow, must of Necessity render the Country uninhabitable. It is true, they are not wholly deprived of Light all that Time, the Moon being most part of that Time, especially about the Full, above their Horizon, and the Sun daily affording them some Twilight: but these Helps are much obstructed by Snow, Clouds and Rain, with thick Fogs, which prevent the Sight of distant Objects. Hence Barrenness, and all rough-hewn and uncultivated: For the Opinion of some, that the nearer the Pole, the less intense the Cold, and the more fruitful the Soil, seems by no means probable, seeing neither in *Nova Zembla* (in 74 Deg. North) nor in *Spitzberg* (in 82 Deg. North) no such Fruitfulness of the Earth, or Temperateness of the Weather is found, but a rough hard Soil, and Snow or Rain, with very piercing Winds in the middle of Summer. Nor is their Opinion much favour'd by the single Instance of a Country about 9 Deg. distant from the Pole (which most think is a Part of *Greenland*) in which is found a green Herb, and a much warmer Air, than in *Nova Zembla*, but no Animals, except Rain-Deer, which are only found in Countries far North, and which grow so fat upon one Month's Pasturage upon that Herb, as to be savory Venison. But the Cause of this single Instance of this kind is manifest in the Soil, which is full of Marshes and Fens, that Herb not being a Grass, but a Sea-weed, other Herb or Tree in this Country being found none. Whence we may conclude, that the Earth here contains some fat, sulphureous Substance, which mix'd with the Water of the Sea or Rivers, produces so fattening a Weed. During Spring in these Parts, the Air is more temperate, but not without Snow, Rains, and intensely cold Polar Winds; and the Heat of the Summer's Sun is so weak, as not in all Places to melt the Snow, much less the Ice, which are thought to have remain'd here in several Places in their primitive State, from the beginning of the World. During the three Summer Months, the Warmth of the Air is tolerable, the Heat of the Sun in some Places among the Mountains being intense; but this Weather is frequently interrupted, so that no Fruit or Corn will ripen here, except in some Places near the Polar Circles.

**SECANT**, is the Right Line drawn from the Centre of a Circle, cutting it, and meeting with the Tangent without. See under *Trigonometry*.

**SECOND**, is the sixtieth Part of a *Minute*.

**SECOND Deliverance**, is a Writ that lies for him, who after a Return of Cattle replevied, adjudged to him that distrained them, by reason of a Default in the Party that replevied, for the replevying of the same Cattle again, upon Security put in for the Re-delivery of them in Case the Distress be justified.

**SECOND**, in *Musick*, is one of the Musick; being only the Distance between any Sound, and the next nearest Sound either higher or lower.

**SECOND Terms**, in *Algebra*, are those where the unknown Quantity has a Degree less than it has in the Term, where it is raised to the highest.

**SECONDARY Circles**, in reference to the Ecliptick, or *Circles of Longitude* of the Stars, are such as passing through the Poles of the Ecliptick, are at Right Angles to the Ecliptick (as the Meridian and Hour Circles are to the Equinoctial.) By the help of these (infinitely many Circles, all Points in the Heavens are referred) to the Ecliptick; that is, any Star, Planet, or other *Phænomenon*, is understood to be in that Point of the Ecliptick which is cut by the *Secondary Semicircle* which passes through such Star or *Phænomenon*. And if two Stars, &c. are thus referred to the same Point of the Ecliptick, they are said to be in *Conjunction*: If in opposite Points, they are said to be in *Opposition*: If they are referred to two Points at a *Quadrant's Distance*, they are said to be in a *Quartile Aspect*: If the Points differ a *sixth Part* of the Ecliptick, the Stars are said to be in a *Sextile Aspect*, &c.

And in general, all Circles which intersect one of the six greater Circles of the Sphere at Right Angles, may be called *Secondary Circles*; as the Azimuths, or Vertical Circles, in respect of the Horizon, &c.

**SECONDARY Planets**, are such as move round others, whom they respect as the Centre of their Motion; tho' they move also along with the Primary Planets in the annual Orbit round the Sun. And these are otherwise called the *Satellites*: Such is the Moon to the Earth; and *Jupiter* hath four moving round him; as *Saturn*, according to *Cassini*, hath five; *Mars*, *Venus*, and *Mercury*, have no Secondary Planets moving round them, that have been yet discovered.

The learned Dr. *Gregory*, in his *Astronomia Geom. & Physica*, Lib. IV. shews and proves at large, That tho' the Motion of the Primary Planets be sufficiently simple and uniform, as being compounded only of a projectile Motion forward in a right Line, which is a Tangent to the Orbit, and a Gravitation towards the Sun at the Centre; and also being at such vast Distances from each other, that the Effects of their mutual Gravitation towards one another are insensible; yet is the Matter far otherwise in reference to the *Secondary Planets*. For every one of these (altho' it chiefly gravitate toward its respective Primary one, as towards its Centre) at equal Distances from the Sun, is attracted towards him with equal accelerated Gravity as the Primary one is towards him; but at a greater Distance with less, at a nearer Distance with greater. From which double Tendency towards the Sun, and towards its own Primary Planet, the Motion



Motion of the *Satellites*, or *Secondary Planets*, comes to be mightily compounded and affected with many Inequalities. As for Instance, he proves,

1. That the *Satellite* shall be continually *accelerated* in its Motion from the time of its *Quadrature* with the Sun, to the next following *Conjunction* or *Opposition*, but that contrariwise, from the *Syzygys* to the *Quadratures*, it shall be *retarded*, and therefore will not always move swifter in or near the *Syzygys*, and slower near the *Quadratures*. From whence will follow,

2. That the Orbits of these *Secondary Planets* will be of a Figure more circular in the *Quadratures*, than in the *Syzygys*, where the swiftness of the Motion will make the Figure of the Orbit more Rectilinear. And therefore the *Satellite* will run farther from its *Primary Planet* in the *Quadratures*, than at the *Syzygys*; so that the Orbit will be a little Elliptical, having the *Primary Planet* for its Centre; and the longer Diameter will coincide with the Line of the *Quadratures*, and the shorter with that of the *Syzygys*.

And these Irregularities will arise, if the Sun's Power of perturbing the Motion of the *Satellite* be excluded, and the Orbit be concentrick with that of the *Primary Planet*. For, if the Orbit be eccentric, it may happen that the *Satellite* shall be farther off from the *Primary* one in the *Syzygys*, and so move slower, than it shall do at the *Quadratures*.

And when this is the Case, that the *Satellite's* Orbit is not a Circle concentrick to the *Primary* Orbit, but an Ellipsis in one of whose Focus's the *Primary Planet* is placed; then the Motion of the *Satellite* will be so disturbed by the Sun, that as it runs into its Orbit, the *Apses* of the Orbit shall be moved sometimes in *Consequentia*, and sometimes in *Antecedentia* (whereas he proves before, that the *Nodes* and *Apses* of the *Primary Planets* are at rest.)

3. When the Plane of the *Satellite's* Orbit is inclined to the Plane of the *Primary* Orbit, the Line of the *Nodes* of the *Secondary* Orbit will be moved in *Antecedentia*, with an angular Motion, and an unequal Velocity; for it will recede most swiftly when the *Nodes* are in *Quadrature* to the Sun; after which, it will move slower; and at the Time of the *Nodes* being in the *Syzygys*, it will be perfectly at rest.

4. The Inclination also of the Plane of the *Secondary* Orbit to the *Primary* one, will be continually varying, and will be *greatest* when the *Nodes* are in the *Syzygys* with the Sun, and *less* (*cæteris paribus*) when they are in the *Quadratures*; and from the Times of the *Nodes* being in the *Syzygys* to the *Quadratures*, it will be always decreasing; and from the Time of their being in the *Quadratures* to the *Syzygys*, continually increasing.

And he proves, that all these Irregularities, whether in any excentrick or concentrick Orbit, will always be something greater when the *Satellite* is in *Conjunction* with the Sun, than when he is in *Opposition* to him.

After this, he proceeds to shew what Errors or Irregularities in the Motion of these *Secondary Planets* will be produced by the Sun, supposing the *Primary Planet* to move in an excentrick Orbit round the Sun. Of which, *Seç. IV, of the said Book IV.*

*SECONDARY Fever, in Physick*, a Fever which arises after a Crisis, or the Discharge of some morbid Matter, as after the Declension of the *Small-Pox* or *Measles*, &c.

*SECRETION*, is the Separation of one Fluid from another in the Body of an Animal or Vegetable, by the Means of Glands, or something analogous to them.

Dr. *Havers* in his *Osteologia*, explains *Glandular Secretion*, by observing, first, That all Motion in its proper Tendency is direct (which is exactly right) and that the Glands which are seated on the sides of the Arteries all over the Body, are so placed, as to favour the Motion of any Particles that strike against them in a Right Line, more than the Veins; and having Pores adapted to the Figure of the Particles which they separate, the Particles endeavour in their Motion to get into those Glandules; and being there received, are separated and distinguished from the rest of the Mass of Blood, and so assume the Form of that Liquor, which we find separated by every Gland. And that the Glands are so situated as to favour the Motion of a Particle in a Right Line more than the Veins, he saith, is apparent from Observation of the gradual Construction of the Arterial Channel.

*SECTA Curiae*, is Suit and Service done by Tenants at the Court of their Lord.

*SECTA Schirarum & Hundredorum*, was the Attendance, Suit and Service done by Tenants in the County and Hundred Courts; and *Quietos esse de hac Sectâ*, was a Privilege to be exempt from such Customary Service.

*SECTA ad Curiam*, is a Writ that lies against him who refuses to perform Suit either to the Court or Court-Baron.

*SECTA facienda per illam quæ habet æniciam partem*, is a Writ to compel the Heir that hath the Elder's Part of the Co-heirs to perform Service for all the Co-parteners.

*SECTA unica tantum facienda pro pluribus hæreditatibus*, is a Writ that lies for that Heir that is distrained by the Lord to more Suits than one, in respect of the Land of diverse Heirs descended unto him.

*SECTIO Cæsaria*. See *Hysteratomotocia*.

*SECTION Conick*, is the Figure made by the Solidity of a Cone's being supposed to be cut by a Plane.

If the *Section* be made by the *Axis*, or through the Vertex, the Figure arising is a Triangle. If by a Plane, parallel to the *Base* of the Cone, or *subcontrarily* posited, the Figure produced is a Circle.

If the *Section* be made parallel to one side of the Cone, the Figure produced is a *Parabola*: If through both sides of the Cone, it is an *Ellipsis*; and if through one side of the Cone, through the Base, and not parallel to the other side of the Cone, it is an *Hyperbola*.

*Archimedes*, *Euclid*, and other ancient Mathematicians, called that only a *Conick Section*, when the Plane cutting the Cone was at *right Angles* to the side of the Cone; and according as the Angle made by the sides of the Cone meeting in the Vertex, as it was a *right*, *obtuse*, or *acute* one, they called it the *Section* of *Right-angled*, *Obtuse-angled*, or *Acute-angled Cone*. By which Words they understood what we now call the *Parabola*, the *Hyperbola*, and the *Ellipsis*: which three *Sections* (as also the Circle) *Apollonius Pergæus* (justly called



*Magnus Geometra*) found out to be producible in any Cone, according to the four ways of cutting it, as above-mentioned.

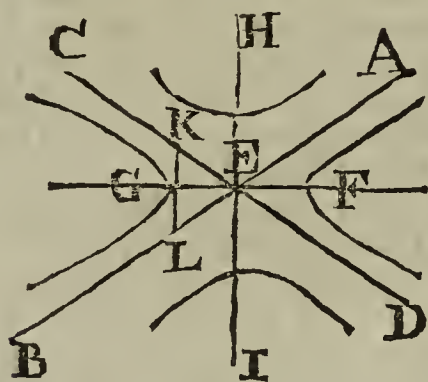
SECTION, in *Mathematicks*, signifies the cutting of one Plane by another, or a Solid by a Plane.

The common Section of two Planes is always a right Line, being the Line supposed to be drawn on one Plane by the Section of the other, or by its Entrance into it.

SECTION of a Building, in *Architecture*, is understood of the Profile or Delineation of its Heights and Depths raised on the Plane; as if the Fabrick were cut afunder to discover the Inside.

SECTIS *non faciendis*, is a Writ that lies for a Woman, who, for her Dower, ought not to perform Suit of Court.

SECTIONES *Sequentes*, is a Term in Conicks arising thus:



Let there be two Right Lines, as *AB*, *CD*, mutually intersecting each other in *E*; which Point *E* is supposed to be the Common Centre of the opposite Hyperbolick Sections, *FG*, *HI*, and whose common Asymptotes the proposed Lines *AB*, *CD*, also are. In this particular Case, the Sections *GF*, and *HI*, are called *Sectiones Sequentis*, because they are placed following one another in the Contiguous Angles of two intersecting Right Lines.

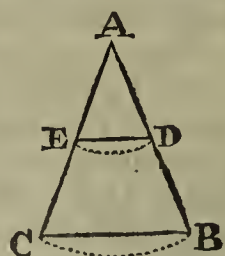
And if the determinate Diameter *HG*, of one of the *Sectiones Sequentes* (which is coincident with the supposed indeterminate Diameter of its Opposite) be equal to the Vertical Tangent *KL*, applied between the Asymptotes in the Point *G*, of the Diameter *GF*, then *Apollonius* calls such Sections *Conjugate Sections*.

SECTOR, is an Instrument made of Wood, Ivory, Brass, &c. with a Joint, and sometimes a Piece to turn out to make a true Square, with Lines of Sines, Tangents, Secants, Equal Parts, Rhumbs, Polygons, Hours, Latitudes, Metals, Solids, &c. and is generally useful in all the Practical Parts of the Mathematicks, and particularly contrived for *Navigation*, *Surveying*, *Astronomy*, *Dyalling*, *Projection of the Sphere*, &c. By *Gunter*, *Foster*, *Collins*, and others. There are likewise Sectors for *Fortification* and *Gunnery*, by Sir *Jonas Moor*.

The great Advantage of the Sector above any other Rule or Plain-Scale, is that all its Lines can be accommodated to any Radius; which is done by taking off all Divisions Parallelwise, and not Lengthwise. The Ground of which Practice is this, that Parallels to the Base of any Plain Triangle, bear the same Proportion to it :: As the Parts of the Legs above the Parallel do to the whole Legs.

The Sector is founded on the fourth Proposition of the sixth Book of *Euclid*; where it is demon-

strated, that similar Triangles have their homologous Sides proportional. An Idea of its Foundation may be conceived thus; Let the Lines *AB*, *AC* (*Fig. 1.*) represent the Legs of the Sector, and *AD*, *AE*, two equal Sections from the Centre. If now the Points *C*, *B* and *D*, *E* be connected, the Lines *CB* and *DE* will be parallel; therefore the Triangles *ADE*, *ABC* similar, and consequently the Sides *AD*, *DE*, *AB* and *BC* proportional: That is, as *AD* : *DE* :: *AB* : *BC*; whence if *AD* be the half, third or fourth Part of *AB*, *DE* will be a half, third or fourth Part of *CB*, and the same holds of all the rest. If, therefore, *AD* be the Chord, Sine or Tangent of any Number of Degrees to the Radius *AB*, *DE* will be the same to the Radius *BC*.



#### Description of the SECTOR.

The Sector consists of two equal Rules, or Legs, of Brass or other Matter, rivetted together, but so as to move easy on the Rivet. See its Figure, *Fig. 15*. On the Faces of the Instrument are placed several Lines; the principal are the Line of equal Parts, Line of Chords, Line of Sines, Line of Tangents, Line of Secants, and Line of Polygons.

The Line of equal Parts, called also Line of Lines, marked *L*, is a Line divided into an hundred equal Parts; and, where the Length of the Leg will allow it, each is subdivided into Halves and Quarters. 'Tis found on each Leg, on the same Side, and the Divisions number'd 1, 2, 3, 4, &c. to 10, which is near the Extremity of each Leg. Note, In Practice, 1 is taken for 10, or 100, or 1000, or 10000, &c. as Occasion requires, in which Cases 2 is taken for 20, or 200, or 2000, &c. and so of the rest. The Line of Chords, mark'd *C* on each Leg, is divided after the usual manner, and number'd 10, 20, 30, &c. to 60; see *Chord*. The Line of Sines, denoted on each Leg by the Letter *S*, is a Line of Natural Sines, number'd 10, 20, 30, &c. to 90; see *Sines*. Line of Tangents, denoted on each Leg by the Letter *T*, is a Line of Natural Tangents, number'd to 10, 20, 30, &c. to 45. Besides which, is another little Line of Tangents on each Leg, commencing at 45 Deg. and extending to 75 Deg. denoted by the Letter *t*; see *Tangent*. Line of Secants, denoted on each Leg by the Letter *S*, is a Line of Natural Secants, number'd 10, 20, 30, &c. to 75 Deg. and commencing not from the Centre of the Instrument, but at two Inches distant therefrom; see *Secant*. Line of Polygons, denoted by the Letter *P* on each Leg, is a Line number'd 4, 5, 6, &c. to 12, which falls three Inches short of the Centre of the Instrument; see *Polygon*.

Beside these Lines, which are essential to the Sector, there are others placed near the outward Edges on both Faces, and parallel thereto, which are, in all respects, the same as in *Gunter's Scale*, and used after the same manner. Such are the Line of Artificial Sines, mark'd *S*; the Line of Artificial Tangents; a Line of 12 Inches, mark'd *In.*; and *Gunter's* Line of Numbers, mark'd *N*. For the Uses of all which, see *Gunter's Scale*. There are sometimes other Lines placed, to fill the



vacant Places, as the Lines of Hours, Latitudes, and Inclinations of Meridians, which are used the same as on common Scales. See *Scales*.

The Lines found by the *Sector* are of two Kinds, Lateral and Parallel. The first are such as are found by the sides of the *Sector*, as A B, A C; the latter such as go across from one Leg to the other, as D E, C B. *Note*, The Order of the Lines in the newer *Sectors*, is different from what it is in the old ones; for the same Line is not now put at the same Distance from the Edge of both Legs; but the Line of Chords, *E. gr.* is innermost upon the one; and the Line of Tangents on the other. The Advantage thereof is, that when the Instrument is set to a Radius for the Chords, it serves also for the Sines and Tangents without stirring it; for the Parallel betwixt 60 and 60 of the Chords, 90 and 90 of the Sines, and 45 and 45 of the Tangents, are all equal.

*The Use of the Line of Equal Parts on the  
S E C T O R.*

1. To divide a given Line into any Number of equal Parts, *E. gr.* seven. Take the given Line in your Compasses, and resting one Foot in a Division of the Line of equal Parts, that may easily be divided by seven, *E. gr.* 70, whose seventh Part is 10. Open the *Sector* 'till the other Point falls exactly on 70, in the same Line in the other Leg. In this Disposition, applying one Point of the Compasses to 10, in the same Line, shut them 'till the other fall in 10 in the same Line of the other Leg. This Aperture will be the seventh Part of the given Line. *Note*, If the Line to be divided be too long to be applied to the Legs of the *Sector*, only divide one Half, or one Fourth by seven, and the Double or Quadruple thereof will be the seventh Part of the Whole.

2. To measure the Lines of the Perimeter of a Polygon, one of which contains a given Number of equal Parts: Take the given Line in your Compasses, and set it over upon the Line of equal Parts, to the Number of Parts on each side expressing its Length. The *Sector* remaining thus, set off the Length of each of the other Lines parallel to the former, and the Numbers each of them falls on will express their Lengths.

3. A Right Line being given, and the Number of Parts it contains, *E. gr.* 120, take from it a less Line, containing any Number of the same Parts, *E. gr.* 25. Taking the given Line in your Compasses, open the *Sector* 'till the two Feet fall on 120 on each Leg; then the Distance from 25 to 25 gives the Line required.

4. To find a third Proportional to two given Lines, and a Fourth to three: For the first, take the Length of the first given Line in your Compasses, and lay it off on the Line of equal Parts from the Centre, to find the Number where it terminates: Then open the *Sector*, 'till the Length of the second Line be included in the Aperture of the Extreme of the first. The *Sector* remaining thus, lay off the Length of the second Line on one of the Legs, from the Centre, and note the Number where it terminates; the Distance between that Number on the two Legs, gives the third Proportional. In the second Case, take the second Line in your Compasses, and opening the *Sector*, apply this Extent to the Ends of the first, laid off from the Centre on both Legs. The *Sector* thus open'd,

lay off the third Line from the Centre, and the Extent between the Number where it terminates on both Legs, is the fourth Proportional.

5. To divide a Line in any given Proportion, *E. gr.* into two Parts, which shall be to each other as 40 to 70, add the two Numbers together, their Sum is 110. Then between your Compasses take the Line proposed, which suppose 165, and open the *Sector* 'till this Distance reach from 110 to 110 on both Legs. The *Sector* thus open'd, take the Extent from 40 to 40, as also from 70 to 70, the first will give 60, the last 105, which will be the Parts propos'd for 40, 70, 60, 105.

6. To open the *Sector*, so as the two Lines of equal Parts may make a Right Angle, find three Numbers that may express the Sides of a Right-angled Triangle, as 3, 4, 5, or their Equimultiples, as 60, 80, 100. Take then in your Compasses the Distances from the Centre to 100; and open the *Sector* 'till one Point set upon 80, the other full upon 60, in the other Leg; then do the two Lines of equal Parts include a right Angle.

7. To find a right Line equal to the Circumference of a Circle, the Diameter of a Circle being to the Circumference nearly as 50 to 157; take the Diameter in your Compasses, and set it over on the Legs of your *Sector* from 50 to 50. The *Sector* thus opened, take the Distance from 157 to 157 in your Compasses, that will be your Circumference required.

*The Use of the Line of Chords on the S E C T O R.*

1. To open the *Sector*, so as the two Lines of Chords may make an Angle of any Number of Degrees, *E. gr.* 40: Take the Distance from the Joint to 40, the Number of Degrees proposed, on the Line of Chords; open the *Sector*, 'till the Distance from 60 to 60, on each Leg, be equal to the afore-said Distance of 40; then does the Line of Chords make the Angle required.

2. The *Sector* being opened, to find the Degrees of its Aperture, take the Extent from 60 to 60, and lay it on the Line of Chords from the Centre; the Number whereon it terminates shews the Degrees of its opening. By applying Sights on the Line of Chords, the *Sector* may be used to take Angles, as a Surveying Instrument.

3. To make an Angle of any given Number of Degrees, with a given Line. On the given Line describe a Circular Arch, the Centre whereof is the Point whereon the Angle is to be made. Set off the Radius from 60 to 60, and the *Sector* remaining thus opened, take the Distance of the two Numbers on each Leg, expressing the proposed Degrees, and lay it from the Line upon the Arch described. Lastly, drawing a Line from the Centre, through the End of the Arch, it will make the Angle proposed.

4. To find the Degrees a given Angle contains: About the Vertex describe an Arch, and open the *Sector*, 'till the Distance from 60 to 60 on each Leg be equal to the Radius of the Circle: Then taking the Chord of the Arch between the Compasses, and carrying it on the Legs of the *Sector*, see what equal Number on each Leg the Point of the Compasses fall on: This is the Quantity of Degrees the given Angle contains.

5. To take an Arch of any Quantity from off the Circumference of a Circle. Open the *Sector*, 'till the Distance from 60 to 60 be equal to the Radius  
of



of the given Circle: Then take the Extent of the Chord, of the Number of Degrees, on each Leg of the *Sector*, and lay it off on the Circumference of the given Circle. By this Use may any regular Polygon be described in a given Circle, as well as by the Line of Polygons.

*The Use of the Line of Polygons of the SECTOR.*

1. To inscribe a Regular Polygon, in a given Circle. Take the Semi-diameter of a given Circle, in the Compasses, and adjust it to the Number 6, on the Line of Polygons on each Leg of the *Sector*: Then the *Sector* remaining thus opened, take the Distance of the two equal Numbers, expressing the Number of Sides the Polygon is to have. *E. gr.* the Distance from 5 to 5 for a Pentagon, from 7 to 7 for a Heptagon, &c. These Distances carried about the Circumference of the Circle, will divide it into so many equal Parts.

2. To describe a regular Polygon, *E. gr.* a Pentagon on a given right Line. Take the length of the Line in the Compasses, and apply it to the Extent of the Number 5, 5, on the Lines of Polygons. The *Sector* thus opened, upon the same Lines take the Extent from 6 to 6, this will be the Semi-diameter of the Circle the Polygon is to be inscribed in. If then with this Distance from the Ends of the given Line, you describe two Arches of a Circle, their Intersection will be the Centre of the Circle.

3. On a right Line, to describe an Isosceles Triangle. Having the Angles at the Base, double those at the Vertex: Open the *Sector* till the Ends of the given Line fall on 10 and 10, on each Leg: Then take the Distance from 6 to 6; this will be the length of the two equal Sides of the Triangle.

*The Use of the Lines of Sines, Tangents, and Secants on the SECTOR.*

By the several Lines disposed on the *Sector*, we have Scales to several Radius's; so that having a Length, or Radius given, not exceeding the Length of the *Sector*, when opened, we find the Chord, Sine, &c. thereto: *E. gr.* Suppose the Chord, Sine or Tangent of 10 Degrees, to a Radius of 3 Inches, required. Make 3 Inches the Aperture between 60 and 60, on the Line of Chords on the two Legs; then will the same Extent reach from 45 to 45 on the Line of Tangents, and from 90 to 90 on the Line of Sines on the other Side; so that to whatsoever Radius the Line of Chords is set, to the same are all the other set. In this Disposition therefore, if the Aperture between 10 and 10, on the Lines of Chords, be taken with the Compasses, it will give the Chord of 10 Degrees. If the Aperture between 10 and 10 be in like manner taken on the Line of Tangents, it gives the Tangent of 10 Degrees.

If the Chord or Tangent of 70 Degrees were required; for the Chord the Aperture of half the Arch, *viz.* 35, must be taken as before; which Distance repeated twice, gives the Chord of 70 Degrees.

To find the Tangent of 76 Degrees to the same Radius, the small Line of Tangents must be used, the other only reaching to 45. Making therefore three Inches the Aperture between 45 and 45 on the small Line, the Extent between 70 and 70

Degrees on the same, will be the Tangent to 70 to three Inches Radius.

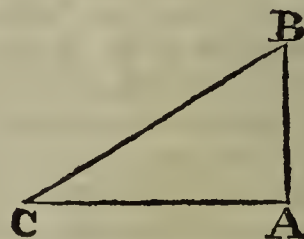
To find the Secant of an Arch, make the given Radius the Aperture between 0 and 0 on the Lines of Secants; then will the Aperture of 10 and 10, or 70 and 70, on the said Lines, give the Tangent of 10 or 70.

If the Converse of any of these things were required; that is, if the Radius be required, to which a given Line is the Sine, Tangent or Secant, 'tis but making the given Line, if a Chord be the Aperture on the Line of Chords between 10 and 10, and then the *Sector* will stand at the Radius required; that is, the Aperture between 60 and 60, on the said Line, is the Radius. If the given Line were a Sine, Tangent or Secant, 'tis but making it the Aperture of the given Number of Degrees 45 and 45 on the Tangents, of 0 and 0 on the Secants, be the Radius.

*The Use of the SECTOR in Right-angled Trigonometry.*

C A S E I.

Given the  $\left\{ \begin{array}{l} \text{Hypothenuse } BC \ 500 \\ \text{Angle } C \ 37^\circ \\ \text{Angle } B \ 53^\circ \end{array} \right\}$  Required the Perpend.  $AB$ , and Base  $BC$ ?



*Rule.* Take 500 from the Line of Lines, and set as a Parallel from 90 to 90 on the Lines of Sines; then the Extent from 37 to 37 on the Sines will be 300, the Length of the Perpendicular; and the Extent from 53 to 53 on the Sines will be 400, the Length of the Base.

C A S E II.

Given the  $\left\{ \begin{array}{l} \text{Angle } B \ 53^\circ \\ \text{Angle } C \ 37^\circ \\ \text{Perpendicular } AB \ 300 \end{array} \right\}$  Required the Hypoth.  $BC$  and Base  $AC$ ?

*Rule.* Take 300 in the Compasses, and set as a Parallel from 37 to 37 on the Lines of Sines; then the parallel Distance from 90 to 90 on the Sines will be 500, when measured on the Line of Lines, for the Hypothenuse; and the parallel Distance from 53 to 53 on the Sines, will be 400 for the Base.

C A S E III.

Given the  $\left\{ \begin{array}{l} \text{Angle } B \ 53^\circ \\ \text{Angle } C \ 37^\circ \\ \text{Base } AC \ 400 \end{array} \right\}$  Required the Hypothenuse  $BC$ , and Perpendicular  $AB$ ?

*Rule.* Take 400 in the Compasses, and set as a Parallel from 53 to 53 on the Lines of Sines; then the Parallel Distance from 90 to 90 on the Sines, will be 500 for the Hypothenuse; and the parallel Distance from 37 to 37 on the same Lines, will be 300 for the Perpendicular, as was required.



## C A S E IV.

Given the  $\left\{ \begin{array}{l} \text{Hypoth. } BC \ 500 \\ \text{Perpend. } AB \ 300 \end{array} \right\}$  Required the Angles  $B \ \& \ C \ \& \ \text{Base } AC?$

*Rule.* Take 500 and set as a Parallel from 90 to 90 on the Lines of Sines; then take 300 and apply as a Parallel on the Lines of Sines, and the Compasses will fall in 37 and 37 for the Angle  $C$ , which subtracted from 90, leaves 53 for the Angle  $B$ , and the parallel Distance from 53 to 53 will be 400 for the Base required.

## C A S E V.

Given the  $\left\{ \begin{array}{l} \text{Hypoth. } BC \ 500 \\ \text{Base } AC \ 400 \end{array} \right\}$  Required the Angles  $B \ \& \ C$  and the Perpendicular  $AB?$

*Rule.* Take 500 and set as a Parallel from 90 to 90 on the Lines of Sines; and, the *Sector* remaining in that Position, 400 applied as a Parallel on the Lines of Sines will fall in 53 and 53 for the Angle  $B$ , which subtracted from 90, leaves 37 for the Angle  $C$ ; then the parallel Distance from 37 to 37 on the Sines will be 300 for the Perpendicular, as was required.

## C A S E VI.

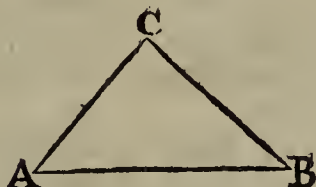
Given the  $\left\{ \begin{array}{l} \text{Perpend. } AB \ 300 \\ \text{Base } AC \ 400 \end{array} \right\}$  Required the Angles  $B \ \& \ C$ , and the Hypotenuse  $BC?$

*Rule.* Take 300 from the Line of Lines, and set as a Parallel from 45 to 45 on the Lines of Tangents; the *Sector* remaining at that opening, take 400 and apply as a Parallel on the Tangents, the Compasses will fall in 53 and 53 for the Angle  $B$ , which subtracted from 90, leaves 37 for the Angle  $C$ ; lastly, taking 300 in the Compasses, and setting as a Parallel from 37 to 37 on the Sines, the parallel Distance from 90 to 90 on the Sines, will be 500 for the Hypotenuse.

*The Use of the SECTOR in Oblique, Right-lined Triangles.*

## C A S E I.

Given the  $\left\{ \begin{array}{l} \text{Angle } A \ 55^\circ \\ \text{Angle } B \ 20^\circ \\ \text{Angle } C \ 105^\circ \\ \text{Side } AB \ 145 \end{array} \right\}$  Required the Sides  $AC \ \& \ BC?$



*Rule.* Take 145 and set as a Parallel on the Sines from 75, the Complement of 105, to 75 on the Sines, and the Parallel from 55 to 55 on the Sines will be 125 for the Side  $BC$ ; also the Parallel from 20 to 20 on the Sines will be 51 for the Side  $AC$ .

## C A S E II.

Given the  $\left\{ \begin{array}{l} \text{Side } AC \ 46 \\ \text{Side } BC \ 64 \\ \text{Angle } A \ 46^\circ 30' \end{array} \right\}$  Required the Angles  $B \ \& \ C$ , and the Side  $AB?$

*Rule.* Make 64 a Parallel at  $46^\circ 30'$ , and then 46 applied as a Parallel, will fall in  $31^\circ 25'$  on the Sines, for the Angle  $B$ ; then the Sum of the Angles  $A$  and  $B$  subtracted from  $180^\circ$ , leaves the Angle  $C \ 102^\circ 5'$ ; lastly, open the *Sector* so that the Lines of Lines may make an Angle of  $102^\circ 5'$ , and the parallel Distance from 64 on the one Leg to 46 on the other, will give 86 for the Side  $AB$ .

## C A S E III.

Given the  $\left\{ \begin{array}{l} \text{Side } AC \ 52 \\ \text{Side } AB \ 74 \\ \text{Angle } A \ 68 \end{array} \right\}$  Required the Angles  $B \ \& \ C$ , and the Side  $BC?$

*Rule.* Open the *Sector* 'till the Lines of Sines make an Angle of 68 Degrees, then the parallel Distance from 52 to 74 on the Lines of Lines will be 73 for the Side  $BC$ ; then, by *Case 3d*, the Angle  $B$  will be found to be  $41^\circ 30'$ , and the Angle  $C \ 70^\circ 30'$ .

## C A S E IV.

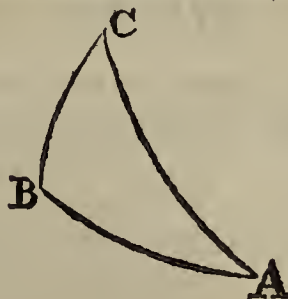
Given the  $\left\{ \begin{array}{l} \text{Side } AB \ 926 \\ \text{Side } AC \ 558 \\ \text{Side } BC \ 702 \end{array} \right\}$  Required the Angles  $A, B \ \& \ C?$

*Rule.* Make the Sides  $AB, AC$ , Laterals on the Lines of Sines, and set over  $BC$  as a Parallel in their Terms; then the opening of the Lines of Sines will be the Angle  $A \ 49^\circ 8'$ , and by setting  $AB$  and  $BC$  as Laterals, and  $AC$  as a Parallel, the Lines of Sines will be open to the Angle  $B \ 36^\circ 57'$ ; lastly, the Sum of the Angles  $A$  and  $B$  subtracted from  $180$ , leaves  $93^\circ 55'$  for the Angle  $C$ .

*The Use of the SECTOR in Spherical Trigonometry.*

## C A S E I.

Given the  $\left\{ \begin{array}{l} \text{Hypotenuse } AC \ 43^\circ \\ \text{Angle } CAB \ 20^\circ \end{array} \right\}$  Required the Side  $CB?$



*Rule.* Take the Lateral of  $20^\circ$  from the Line of Sines, and set as a Lateral from 90 to 90 on the said Lines; then the Parallel of  $43^\circ$  when measur'd from the Centre will give on the Sines  $13^\circ 30'$ , the Side required.

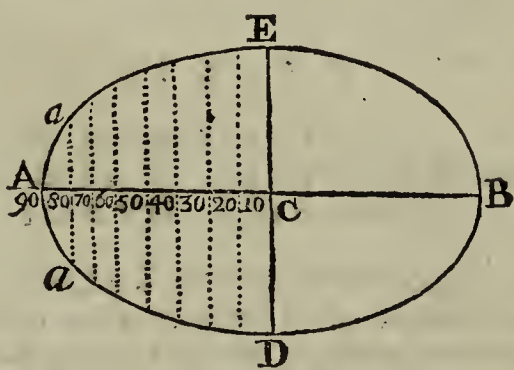


## C A S E II.

Given the  $\begin{cases} \text{Hypothenufe } AC \ 43^\circ \\ \text{Perpendic. } BC \ 76^\circ \ 30' \end{cases}$  Required the Base  $AB$ ?

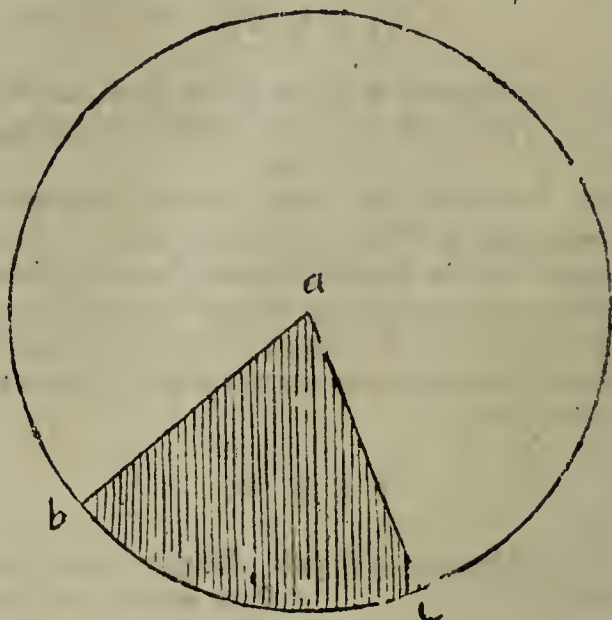
*Rule.* Take the Radius and set as a parallel Sine to the given Perpendicular; then take the Parallel of the Sine Complement of the Hypothenufe  $47^\circ$ , measur'd as a Lateral on the Sines, will give  $49^\circ \ 25'$ , their Complement of the Base requir'd; consequently the Base itself will be  $40^\circ \ 35'$ .

To describe an Ellipsis, by having the Transverse  $AB$  and Conjugate Diameters  $ED$  given.



*Rule.* Make  $AC$  a Parallel from 90 to 90 on the Sines; then divide the Line  $AC$  into a Line of Sines, by taking the parallel Extents of the Sine of each Degree, or of every tenth Sine, on the Legs of the Sector in your Compasses, and laying them off from the Centre  $C$ : From each Division raise Perpendiculars both ways; then find Points in those Perpendiculars, through which the Ellipsis must pass, thus: Take the Semi-conjugate Diameter  $CE$  between your Compasses, and open the Sector 'till the Aperture of 90 and 90 on the Line of Sines be equal thereto: Then take the parallel Sines of each Degree of the Line of Sines of the Sector, and lay them off on those Perpendiculars drawn through their Complements in the Line of Sines  $AC$ ; thus will you have two Points in each Perpendicular, through which the Ellipsis must pass. *E. gr.* The Sector still remaining the same, take the Distance from 80 to 80 on the Lines of Sines in your Compasses, and setting one Foot in the Point 10, on the Line  $AC$ , with the other make the Points  $a$  and  $b$  in the Perpendiculars passing through that Point; then will  $a$  and  $b$  be the two Points in the Perpendicular through which the Ellipsis must pass. All the other Points, found after the same manner, being connected, will give the Semi-Ellipsis  $DAE$ ; and the other half may be drawn after the same manner.

**SECTOR** of a Circle, is a mixt Triangle comprehended between the Radius and an Ark of the Circle.



As here,

The Sector  $abc$ , made by the Legs  $ab$  and  $ac$ , and the Ark  $bc$ .

To find the superficial Content of any Sector, see *Area*, N. 9.

**SECUNDA** *superoneratione pasturæ*, is a Writ that lies where Admeasurement of Pasture hath been made; and he that first surcharged the Common, doth again surcharge it, notwithstanding the Admeasurement.

**SECUNDANS**, in *Mathematicks*, is an infinite Series of Numbers, beginning from Nothing, proceeding as the Squares of Numbers in Arithmetical Proportion.

As for Instance,

0, 2, 4, 9, 16, 25, 36, 49, 64, &c.

**SECUNDARY**; that Officer who is the second, or next to the chief Officer; as the *Secondaries* of the Fine Office; the *Secondaries* of the Compters, who is next to the Sheriff of London in each of the two Compters; *Secondary* of the Office of the Privy-Seal; *Secondaries* of the Pipe, two; *Secondary* to the Remembrancers, who are two Officers in the Exchequer.

**SECUNDINE**, the Secundine, or After-Birth, are the three Membranes, *Chorion*, *Alantois*, and *Amnion*, which, with the *Placenta*, are excluded after the Birth.

**SECUNDI Generis**, in *Anatomy*, a Distinction among the Lacteal Vessels, which are of two kinds, those of *Primi generis*, which carry the Chyle from the Intestines into the Glands, dispersed in great Numbers throughout the Mesentery: And those *Secundi generis*, which carry it from these Glands after it has there been diluted with *Lympha* into the common Receptacle.

**SECURITATE pacis**, is a Writ that lies for one who is threatned Death or Danger, against him that so threatneth, and is taken out of the *Chancery*, and directed to the Sheriff.

**SECURITATEM inveniendi quod se non divertat ad partes externas sine licentia Regis**, is a Writ that lies for the King against any of his Subjects, to stay them from going out of his Kingdom: The Ground of which is, that every Man is bound to serve and defend the Commonwealth, as the King shall think meet.



SE *defendendo*, is a Plea for him that is charged with the Death of another, saying, he was necessitated to do that which he did in his *own Defence*; the other so assaulting him, that if he had not done as he did, he must have been in Hazard of his own Life; but this Danger ought to be so great, that it seems inevitable: And tho' he justify it to be done in his own Defence, yet he is driven to procure his Pardon of course from the Lord-Chancellor, and forfeits his Goods to the King.

SEDIMENTUM *Urinæ*, the Sediment of Urine, are Parts of the nutritious Juice, which being separated from the Blood, with the *Serum*, because of their Gravity, sink to the Bottom of the Urine.

SEEL, a Sea Word, much of the same Sense with *Heel*; for as they call it *heeling*, when a Ship lies down constantly or steadily on one side, so they call it *feeling*, when she tumbles on one side violently and suddenly, by reason of the Sea forsaking her, as they call it; *i. e.* the Waves leaving of her for a time in a rowling Sea: When a Ship thus tumbles to *Lee-ward*, they call it *Lee-feel*; and in this there is not much Danger, even in a Storm, because the Sea will presently right her up again; but if she rows or feels to Windward, there is fear of her coming over too short or suddenly, and so by having the Sea break right into her, be either founder'd, or else have some of her upper Works carried away.

SEEING. The Sense of Seeing is probably caused thus; the Rays of Light exhibiting all Colours, fall upon the Bottom of the Eye, and there cause or excite *Vibrations* in the *Tunica Retinæ*; which Vibrations being communicated, or propagated along the solid Fibres of the Optick Nerves into the Brain, do there cause that Sensation, which we call Vision, or Seeing: For because dense Bodies conserve their Heat a long while, and the densest the longest time, the Vibrations of their Parts are of a lasting nature, and therefore may be propagated along solid Fibres of uniform Density to a great Distance, for conveying into the Brain the Impressions made upon all the Organs of the Sense. For that Motion which can continue long in one and the same Part of a Body, can be propagated a long way from one Part to another, supposing the Body homogeneous; so that the Motion may not be reflected, refracted, interrupted, or disorder'd by any unevenness of the Body. *Newton's Opticks, Book III.*

The same Author renders it probable, that the Species of Objects seen with both Eyes, are united in that Place where the Optick Nerves meet and join, before they come into the Brain: The Fibres on the right side of both Nerves uniting there, and after Union, going thence into the Brain in the Nerve, which is on the right side of the Head; and the Fibres on the left side of both Nerves uniting in the same Place, and after Union going into the Brain in the Nerve, which is on the left side of the Head: And these two latter Nerves meet and unite in the Brain, in such a manner that their Fibres make but one entire Species, or Picture: Half of which, *viz.* that on the right side of the *Sensorium* comes from the right side of both Eyes, thro' the side of both the Optick Nerves, to the Place where these Nerves meet, and from thence on the right side of the Head into the Brain: But the other half, *viz.* that on the left side of the *Sensorium*, comes in like manner from the left side of

both Eyes. For the Optick Nerves of such Animals as look the same way with both Eyes (as of Men, Dogs, Sheep, Oxen, &c.) meet before they come into the Brain; but the Optick Nerves of such Animals as do not look the same way with both Eyes (as of Fishes, and the Chamælion) do not so meet and unite, if I am rightly informed.

When a Man in the Dark presses either Corner of his Eye with his Finger, and at the same time turns his Eye a contrary way, he will see a Circle of Colours, like those in the Feather of a Peacock's Tail; which variegated Circle of Colours, seems to arise from the same kind of Motions excited in the Bottom of the Eye by the Pressure of the Finger, as at other times are excited there by Light for causing Vision. And when a Man by a Stroke upon his Eyes sees a Flash of Light, are not the like Motions excited in the *Retina* by that Stroke?

SEGMENT of a Circle, is a Figure contain'd between a Chord and an Ark of the same Circle.

To find the Superficial Content of any Segment of a Circle, see *Area*, N. 10.

SEGMENT of a Sphere, is a Part of it cut off by a Plane; and therefore the Base of such a Segment must always be a Circle, and its Superficies a Part of the Surface of the Sphere.

Its solid Content is found by multiplying the Surface of the whole Sphere, by the Altitude of the Segment, and then dividing the Product by the Diameter of the Sphere, and to the Quotient, adding the *Area* of the Base of the Segment.

Or if it is less than an *Hemisphere*, thus:

Take the Altitude of the Segment from the Radius of the Sphere, and by the Difference multiply the Area of the Base of the Segment; and subtract this Product from that which will arise from multiplying the Semi-Axis of the Sphere into the Convex Surface of the Segment; then divide the Remainder by 3, and the Quotient is the Solidity sought.

This latter Method supposes the Axis of the Sphere to be given; if not, it may be found thus:

Let the Altitude of the Segment be called *a*, and its Semi-diameter *s*.

Then will

$a : s :: s : \frac{s^2}{a}$ ; add  $\frac{s^2}{a}$  to *a*, and that shall give the Axis sought. 13. 1. 6. *Euclid*.

SEGMENTS. On *Gunter's Sector* there are usually placed two Lines, called *Lines of Segments*; they are number'd with 5, 6, 7, 8, 9, 10, and lie between the Lines of *Sines*, and those of *Superficies*. They represent the Diameter of a Circle so divided into an hundred Parts, as that a right Line drawn through those Parts, and normal to the Diameter, shall cut the Circle into two Segments, of which the greater shall have that Proportion to the whole Circle, as the Parts cut have to an hundred. Their Uses are,

1. To divide a given Circle into two Segments, which shall have a given Ratio; which is done by opening the *Sector*, and applying the given Circle's Diameter in the Points of 100 in these Lines; for

then



then a Parallel taken from any Points proportional to the greater Segment required, shall give the *Depth* of the greater Segment, accounted on a Diameter bisecting the Segment.

2. To find the Proportion between the Circle and any given Segment of it.

Open the *Sector*, as before, and then take the *Depth* of the greater Segments, and apply parallel to the Diameter, and the Points where it fits in exactly, will shew the Proportion to 100.

SEGMOIDALES, or *Semilunaries*, are Valves of the *Arteria Pulmonaria*, and are so called, because they resemble a Half-moon, or Segment of a Circle; their Substance is Membranous: When they separate, they give Passage to the Blood, from the Ventricle into the Artery; but they shut the Passage, and are thrust together by the Blood, if it endeavours to return.

SEGREIANT, the Herald's Word for *Griffins*, when drawn in a leaping or saliant Posture.

SEJANT (*i. e.* fitting) the Term is used in Heraldry for a Lion, or other Beast, when it is drawn in an Escutcheon fitting like a Cat, with his Forefeet straight.

SEIGNOURAGE, 9 *Hen. 5. Stat. 2. c. 1.* seems to have been a Royalty or Prerogative of the Prince, whereby he challenged Allowance of Gold and Silver brought into the Mass for his Exchange for Coin. Out of every Pound Weight of Gold, the King had for his Coin five Shillings, out of which he paid to the Master of the Mint for his Work, sometimes one Shilling, and sometimes Eighteen Pence. Upon every Pound Weight of Silver the *Seignourage* answered to the King, in *Edward the Third's* Time was Eighteen Pennyweight *pondere*, which about that time amounted to about a Shilling, and out of which he paid sometimes eight, sometimes nine Pence to the Mint-master. In *Henry the Fifth's* Time the King's *Seignourage* for every Pound Weight of Silver was fifteen Pence.

SEISIN, from the *French Seisine, possessio*: So *primier Seisin*, is the first Possession; and *to seise*, is to take Possession.

*Seisin*, according to the Common Law, is twofold; *Seisin in Fact*, and *Seisin in Law*.

*Seisin in Fact*, is when a Corporal Possession is taken.

*Seisin in Law*, when something is done which the Law accounteth a *Seisin*, as an Inrolment: And this *Seisin in Law*, is as much as a Right to Lands and Tenements, though the Owner be by Wrong disleased of them: And he who hath had an Hour's Possession quietly taken, hath *Seisin de droit & de claime*, whereof no Man may disleise him by his own Force or Subtily, but must be driven to his Action; and 'tis called by *Coke*, *Seisin in Law*, or *Actual Seisin*.

The *Civilians* call the one *Civilem Possessionem*, the other *Naturalem*.

SEISINA habenda, quia Rex habuit annum, diem & vastum, is a Writ that lies for Delivery of *Seisin* to the Lord of his Lands or Tenements, after the King, in the Right of his Prerogative, hath had the Years, Day, and Waste.

SEISING, or *Seasing*, in the Sea Language, is the same as *Fastening*, *viz.* of two Ropes together with some Rope-yarn, &c. Also the fastening of a Block at the end of a Pendant or Tackle, Garnet, &c. is called *Seising*.

The *Boat's seasing*, is a Rope by which a Ring, or little Chain is made fast in the Foreship of the

Boat, whereby, in a Harbour, the Boat is fastened to the Ship's side.

SELENOGRAPHY, [*σεληνογραφία*, of *σελήνη* the Moon, and *γραφῆ*, *Gr. Description*] a Branch of Cosmography, that describes the Moon, and all the Parts and Appearances of it, as Geography does those of the Earth.

SELL, in *Architecture*, is the Term both for the lowest Piece of Timber in a Timber-Building, or for that on which the whole Superstructure is erected, and also for the Bottom-pieces in a Window-frame; the former is called a *Ground-sell*, the latter a *Window-sell*.

SELLA Equina, seu *Turcica*, or *Sphænoïdes*, a Part of the Brain, compounded of four Processes of the Bone *Sphænoïdes*, or the Wedge-like Bone; it contains the *Pituitarian Glandule*, and in Brutes, the *Rete Mirabile*.

SEME, *Summa*, is an Horse-load; a *Seme of Corn* is eight Bushels.

SEMEIOSIS. See *Diagnosis*.

SEMEIOTICA [*σημειωτική*, *Gr.*] is that Part of Physick, or the Art of Medicine, which treats of the Signs of Health and Sickness; assisting the Physician to make probable Guesses and Conjectures of the Constitution and State of his Patient.

SEMETS, according to *Dr. Grew*, are the Apices of the Attire of a Plant. See *Apices*.

SEMI-BREVE, a Term in Musick. See *Notes and Time*.

SEMI-CIRCLE, is the Figure contained between the Diameter of a Circle and half the Circumference.

Also an Instrument for *Surveying*, made of Brass, and divided into 180 Degrees, being half the *Theodolite*.

SEMI-COLON, is a Stop, or Point in a Sentence, between a *Comma* and a *Colon*, and mark'd thus (;) and expresses a Pause greater than the former, and less than the latter.

SEMI-CUBICAL Paraboloid, is a Curve whose Ordinates are in *Subtriplicate of the Duplicate* proportion of the Diameter; that is, the Cubes of the Ordinates are as the Squares of the Diameters.

In this *Paraboloid*, the Segments of the Curve, cut by Ordinates (at equal Distances) are as the Ordinates in a *Parabola*; and therefore their Squares increased by Equals in Arithmetical Progression; and consequently that Curve to a Right Line, as the Trunk of a *Parabola* to a *Parabola*.

SEMI-CUPIUM, is a Bath, in which the Patient is only up to the Navel in Water.

SEMI-DIAMETER, or *Radius*, is that Line that is drawn from the Centre to the Circumference of a Circle.

SEMI-DIAMETER, in *Fortification*, is twofold, *viz.* the Greater and Lesser: The former being a Line composed of the Capital, and the small Semi-diameter of the Polygon: And the other, a Line drawn to the Circumference from the Centre thro' the *Gorges*.

SEMI-DIAPASON, a Term in Musick, signifying a *Defective* or *Imperfect Octave*.

SEMI-DIAPENTE, a Term in Musick, signifying an *Imperfect Fifth*.

SEMI-DITONE, in Musick, is the lesser Third, having its Terms as six to five.

SEMI-LUNARES *Valvulae*. See *Segmoidales*.

SEMI-



**SEMI-MEMBRANOSUS**, is a Muscle of the Leg, so called from its being half Tendinous and Membrane-like, lying immediately under the *Seminervosus*: It ariseth broad and tendinous from the Protuberance of the *Os Ischium*, and in its Descent becomes broader; and in less than half its Progress begins to grow fleshy, and is dilated into a large and fleshy Belly, lying under the long round Tendon of the *Semi-nervosus*, becoming a short thick Tendon, inserted to the superior Part of the upper Appendix of the *Tibia* backwards. Its use is to help to bend the *Tibia*.

**SEMI-ORDINATES**, in Geometry, are the Halves of the *Ordinates* or *Applicates*.

**SEMI-PARABOLA**, in Geometry, is a Curve defin'd by the Equation  $ax^m + 1 = y^m$ ; as  $ax^2 = y^3$ ,  $ax^3 = y^4$ .

**SEMINAL Leaves**; much the greatest Part of all Seeds which are sown in the Earth, come up, or shoot forth at first with two little, plain, soft, and undivided Leaves; which because they are usually very different from the Leaves of the succeeding Plant in Magnitude, Figure, Surface, and Position, are called very properly by this Name *Seminal Leaves*: As the little embrionated Plant which lies in Miniature in every Seed, is called, the *Plantula Seminalis*.

**SEMI-NERVOSUS**, seu *Semi-tendinosus*, a Muscle of the Thigh, which is so called from its being half Tendinous, and Nerve-like. It ariseth partly Tendinous, and partly Fleshy, from the external Part of the Protuberance of the *Os Ischium*, and presently being dilated to a large fleshy Belly, becomes a round Tendon in half its Progress, which descending over the fleshy Belly of the *Semi-membranosus*, marcheth close by the *Gasterocnemius*, on the posterior Part of the superior Appendix of the *Tibia*; from whence it passes forwards to its Insertion in the said Bone immediately below the Termination of the *Gracilis*: This with the *Gracilis* acting, bend the *Tibia* directly backwards. Its Tendon, together with the *Sartorius*, *Gracilis*, *Semi-membranosus*, and *Biceps*, make the inward Hamstrings, as they are commonly called.

**SEMI-QUADRATE**, the same with *Semi-quartile*.

**SEMI-QUARTILE**, an Aspect of the Planets when distant from each other 45 Degrees, or one Sign and a half.

**SEMI-QUAVER**, a Term in Musick. See *Notes* and *Time*.

**SEMI-QUINTILE**, an Aspect of the Planets, when at the Distance of 36 Degrees from one another.

**SEMI-SEXTILE**, an Aspect of the Planets, when distant from one another 30 Degrees, or one Sign, and is noted thus, SS.

**SEMI-SPINATUS**, is a Muscle which seems to be a Continuation of the *Sacer*; and therefore may not improperly be called *Transversalis Dorsi*; it ariseth fleshy from all the Transverse Processes of the *Vertebrae* of the *Thorax*, and marching obliquely upwards, is inserted to the superior Spines of the said *Vertebrae*: These with the *Quadratus Lumborum Sacer*, and *Transversales Colli*, acting, move the whole Spine, or *Vertebrae* of the Neck, Back, and Loins, obliquely backwards, as when we endeavour to look very much behind us: If they all act together on each side, they assist in erecting the Trunk of the Body.

**SEMI-TENDINOSUS**. Vide *Semi-nervosus*.  
V O L. II.

**SEMI-TONE**, a Term in Musick, of which there are two sorts, viz. a Greater and a Lesser; the *Enharmonical Deisis*, being the Difference between them.

**SEMITA Luminosa**, is a Name given by Mr. Childry in his *Britannia Baconica*, p. 183, 184, to a kind of lucid Track in the Heavens, which a little before the Vernal Equinox (he saith) may be seen about six a Clock at Night, extending from the Western Edge of the Horizon up towards the *Pleiades*.

After this, the *Phænomenon* was taken notice of by *Cassini* and *Fatio*, who both evince, that this Light comes diffused from each side of the Sun: Its Brightness is much the same with that of the *Via Lactea*, or the Tail of a Comet. 'Tis seen plainest with us about the beginning of *October*, and towards the end of *February*.

*S. Fatio* conjectures, that the Bodies, or rather the Congeries or Aggregate of those Bodies, which occasion the Light, doth conform to the Sun like a *Lens*; and takes it to have ever been the same: But *Cassini* thinks it arises from a vast Number of small Planets which encompass the Sun, and give this Light by Reflection, esteeming it also not to have existed long before he observed it: But this latter is overthrown by *Childry's* Observations, whose Book was printed in 1661; and he saith there, he had taken notice of it for many Years.

**SEND**, when a Ship is either at an Anchor, or under Sail, falls with her Head, or Stern, deep into the *Trough of the Sea* (i. e. into a Hollow made between two Waves or Billows) they say she *sends* much that Way, whether it be *A-head*, or *A-stern*.

**SENE SCALLO & Marefhallo quod non teneant placita de libero tenemento**, &c. is a Writ directed to the Steward, or Marshal of *England*, inhibiting them to take Cognizance of any Action in their Court that concerns either Freehold, Debt, or Covenant.

**SENE SCHAL**, was the Word anciently for the Chief Steward or Head Bailiff of a Baron, that kept his Courts, and managed his Demesne-lands, and hath been the Title of the Lord High Steward, and of the Steward of the King's Household, &c.

**SENSATION**, is the perceiving of things by our Senses; and is the Original of most of the Ideas which we have, which by our Senses are derived to our Understanding.

The *Cartesians* assert Sensation to be only a simple Perception, whereby the Motions of external Objects affecting the Extremities of the Nerves in the Organs of the Body, are communicated all along those Nerves to the *Glandula Pinealis*, where the Soul residing, receives her Informations, and accordingly makes Judgments upon them.

In which (except as to that Whim of the Soul's residing in the *Glandula Pinealis*) they are certainly much in the right: For Sensation is properly and ultimately made in or by the Mind, or discerning Faculty, which probably, from the different Motions of the internal Parts of the Brain, is excited and determined to differing Perceptions; and to these we give differing Names, as Heat, Cold, and other Qualities.

**SENSIBLE Horizon**. See *Horizon*.

**SENSIBLE Point**. See *Point Sensible*.

**SENSITIVE Plants**, are such whose Frame and Constitution is so nice and tender, that at the  
6 K Touch,



Touch, or at the least Pressure of one's Hand, they will contract their Leaves or Flowers, as if they really felt Pain by such a Contact.

Of these the Botanick Writers mention many Kinds, some of which contract with Heat, others with Cold.

**SENSORIUM Commune**, or the Seat of the common Sense, is that Part of the Brain in which the Nerves, from the Organs of all the Senses, are terminated, which is the beginning of the *Medulla Oblongata*.

**SENSORY**, the Organ or Instrument of Sense, as the Eye of Seeing, the Ear of Hearing, &c.

**SENSUS**, *Sense*, is when the Motion impressed by the outward Objects upon the Fibres of the Nerves, is conveyed by the help of the animal Spirits in the Nerves, to the common *Sensory*, or *Medulla Oblongata*.

**SEPARATION**, with some Writers of Navigation, is the same with what is more usually called, the *Departure*; that is, a Ship's Difference of Longitude from any Place, or from another Ship. Our Seamen commonly call it *Easting* or *Westing*; according as the Difference of Longitude is East or West.

**SEPHYROS** (in some Authors) is a hard Inflammation of the Womb.

**SEPTAN Fevers**, intermitting Fevers that return every seventh Day.

**SEPTANGULAR**, the same with the *Heptangular*.

**SEPTENTRIONAL Signs**, are the first six Signs of the *Zodiack*, so called, because they decline towards the North from the Equinoctial, and are the same with *Boreal Signs*.

**SEPTICA**, [*σηπτικὰ*, Gr.] *five Putrefacientia*, are those things, which by a malignant Sharpness, rot and corrupt the Flesh.

**SEPTUAGESIMA**, is always the third *Sunday* before *Quadragesima* exclusive; from which, until the *Octaves* after *Easter*, Marriage is forbidden by the Canon-Law. It takes its Name from its being above seventy Days before *Easter*.

**SEPTUM Cordis**, the fleshy Part that divides the right Ventricle of the Heart from the left.

**SEPTUM Lucidum**, is a Partition, which is diaphanous, upon the account of its thinness; it distinguishes the Ventricles of the Brain.

**SEPTUM Medium**, is properly the Inside of the left Ventricle of the Heart, because its Fibres are continued with the Fibres of the opposite side of the same Ventricle; it divides the left Ventricle of the Heart from the right.

**SEPTUM Transversum**. See *Diaphragma*.

**SEQUATUR sub suo periculo**, is a Writ that lies where a Summons *ad Warrantisandum* is awarded, and the Sheriff returns, That he hath nothing whereby he may be summoned; then goes out an *Alias* and *Pluries*; and if he comes not at the *Pluries*, then goes out this Writ.

**SEQUELA Cause**, is the Process and depending Issue of a Cause or Trial.

**SEQUELA Molendini**, is owing Suit to a particular Mill, or being bound to grind Corn in that Place only; which formerly was a Duty and Service laid upon many Tenants; wherefore *Concedere Sequelam Molendini*, was to grant all the Toll and Profits arising from such Customary Rights.

**SEQUESTER**, is a Term used in the Civil Law for renouncing, as when a Widow comes into

Court, and disclaims to have any thing to do, or to intermeddle with her Husband's Estate, who is deceased; she is said to *Sequester*.

**SEQUESTRATION**, is the separating of a Thing in Controversy from the Possession of both those that contend for it: And it is of two sorts; *Voluntary*, or *Necessary*.

*Voluntary*, is that which is done by Consent of each Party.

*Necessary*, is that which the Judge doth of his Authority, whether the Parties will or not.

It is used also for the Act of the Ordinary, disposing of Goods and Chattels of one deceased, whose Estate no Man will meddle with.

Also for the gathering of the Fruits of a Benefice void to the Use of the next Incumbent.

**SEQUESTRO habendo**, is a Writ Judicial, for the dissolving a Sequestration of the Fruits of a Benefice made by a Bishop at the King's Command, thereby to compel the Parson to appear to the Suit of another: For the Parson, upon his Appearance, may have this Writ for the Discharge of the Sequestration.

**SERGEANT**, is a Word diversely used in our Law, and applied to sundry Offices and Callings. A *Sergeant at Law*, or of the Coif, is the greatest Degree taken in that Profession, as that of a Doctor is in the Civil Law. As these are the most learned and experienced, there is one Court appropriated to plead in by themselves, which is the *Common-Pleas*, where the Common Law of *England* is most strictly observed: But though they have this Court to themselves, they are not prohibited Pleading in other Courts; where the Judges (who must be first *Sergeants*) call them *Brothers*. These *Sergeants* are call'd by the King's Mandate, or Writ directed to them, and commanding them, under a great Penalty, to take upon them that Degree by a Day assigned. Out of these one is (more may be) made the *King's Sergeant*, to plead for him in all Causes, especially in Treason.

**SERGEANT at Arms**, is an Officer appointed to attend the Person of the King, *An. Hen. 8. c. 9.* to arrest Traitors, &c. and Persons of Quality offending, and to attend the Lord High Steward when he sits in Judgment on any Traitor, &c. By the Statute 13 *Richard 2. c. 6.* there cannot be above thirty in the Realm. Two of these, by the King's Allowance, attend the two Houses of Parliament. The Office of him in the *House of Commons* is to keep the Door, and to execute such Commands as the House shall direct, especially as to the Apprehension of Offenders, &c.

Another of these attend on the Lord-Chancellor, or Keeper, in the *Chancery*, and one on the Lord High-Treasurer, one to attend on the Lord President of *Wales*, and another on the Lord President of the *North*. Another sort of *Sergeants*, are chief Officers executing several Functions in the King's Household; of which you may find many in Statute 33 *Hen. 8. c. 12.* There is also an inferiour kind of *Sergeants of the Mace*, whereof there is a Troop in the City of *London*, attending the *Lord Mayor*.

**SERJEANTRY**, was a Service formerly done for the holding of Lands, and was either *Grand Serjeantry*, which was some honourable Military Service paid only to the King; as to carry his Banner,



ner, bear his Sword, &c. Or *Petty-Serjeantry*, which was some less noble Service paid to the King, or any other Lord. Some will have *Grand Serjeantry* to be where a Man holds Lands of the King by Service, which he ought to perform in Person, and *Petty-Serjeantry*, to be where he holds his Lands of the King, to yield him yearly some small thing towards his Wants.

**SERIES**, properly speaking, is an orderly Process or Continuation of things one after another. 'Tis commonly in *Algebra* connected with the Word *Infinite*, and there, by *Infinite Series*, is meant certain Progressions, or Ranks of Quantities orderly proceeding, which make continual Approaches to, and if infinitely continued, would become equal to what is enquired after.

This Method took its Rise from the learned Dr. *Wallis's Arithmetick of Infinites*, and has been of late so pursued by several worthy Persons of our own Nation, especially the Incomparable Sir *Isaac Newton*, that it is now one of the greatest Improvements of *Algebra*.

**SEROSITIES**, are serous Humours abounding in the Body.

**SERPENS**, in *Astronomy*, a Constellation in the Northern Hemisphere called *Serpens Ophiuchi*.

The Stars in the Constellation *Serpens*, in *Ptolemy's Catalogue*, are seventeen; in *Tycho's*, nineteen; in the *Britannic Catalogue*, fifty-nine.

**SERPENTARIUS**, in *Astronomy*, a Constellation of the Northern Hemisphere, called also *Ophiuchy*, and anciently *Æsculapius*.

**SERPENTINE**, so the Chymists (from its Figure) call that long winding Worm, which is placed in a Tub of Water in the Distillation of Spirits. See *Worm*.

**SERPENTINE Line**, the same with *Spiral*; which see.

**SERPIGO**. See *Lichen*.

**SERRATUS Major Anticus**, is a Muscle which arises fleshy from the whole *Basis Scapulæ*, and passing under the *subscapularis*, it becomes broader and thicker, still running somewhat forwards 'till it is inserted to the eight superior Ribs laterally, by so many distinct fleshy Portions, or *Digituli*, representing the Teeth of a Saw; the two, and sometimes three inferior of which, are indented with the *Musculus Obliquus Descendens* of the *Abdomen*. This, like the *Serratus Minor Anticus*, dilates the *Thorax*, or moves the *Scapula* forwards and downwards, when its Muscles are relax'd.

**SERRATUS Minor Anticus**, is a Muscle, by Anatomists generally reckoned a Muscle amongst those of the *Scapula*: But we are perswaded (says *Cowper*) from its Position, that it may be equally serviceable to the *Thorax*, in elevating those Ribs it is inserted to. It arises fleshy from the *Processus Caracoides Scapulæ*, and descends obliquely forwards, becomes broader and thinner, and is inserted fleshy to the bony Part of the second, third, fourth, and fifth Ribs. If the *Scapulæ* are elevated by their proper Muscles, this, with its Partner, are then capable of dilating the Breast in large Inspirations. But if they are depress'd, it may be easily conceived with what Difficulty that Action must be performed.

**SERRATUS inferior posticus**, is a Muscle of the *Thorax*, much larger than Authors generally assign it: "In a robust Man we observed its Continuation (says *Cowper*) not only from the Spines of the *Vertebra's* of the Loins, but from all those

" of the *Thorax*, as well underneath as below the former Muscle; its superior and inferior Parts being entirely Tendinous, its Middle growing fleshy near its serrated Termination at the Curvature of the ninth, tenth, eleventh, and Extremity of the twelfth Ribs. The *Ductus* of the Fibres of this passing Transverse, and those of the precedent descending obliquely, do decussate each other in acute Angles; which *Riolan* has well observed, and contrary to the Opinion of Authors, assigns it with its Partner, a different Use in depressing the *Thorax*; both performing the Office of a Bandage in binding together and constringing the posterior Muscles of the Spine, not unlike the constructive Inclosures of the Thigh and Cubit.

**SERRATUS superior posticus**, is a Muscle of the *Thorax*, which lies immediately under the *Rhomboides*: It arises with a thin Tendon from two inferior Spines of the *Vertebræ* of the Neck, and three superior of the *Thorax*; from thence descending obliquely over the *Splenius Capites*, and under Parts of the *Sacro-lumbalis*, and *Dorsi Longissimus*, it becomes fleshy, marching over the *Scapula*, to its Insertion at the Curvature of the second, third and fourth Ribs, by so many distinct fleshy Endings, representing the Teeth of a Saw, whence its Name. This assists in elevating the Ribs or *Thorax*.

**SERVE**, to serve a Rope (in the Sea-Phrase) is to lay upon it Spun-yarn, Rope-yarn, Sinnet, a Piece of Canvas, or the like, which is there rowled fast round about the Rope, to keep it from fretting or galling in any Place.

**SERVICE-Royal**, was the Rights and Prerogatives that within such a Mannor belonged to the King, if Lord of it; and were generally reckoned to be these six. 1. Power of Judicature in Matters of Property. 2. Power of Life and Death in Criminal Cases. 3. A Right in Waifs and Strays. 4. Assessments. 5. Minting of Money. 6. Assize of Bread, Beer, Weights and Measures.

**SERVICE** (which is sometimes called *Servage*) is divided into Personal and Real, and into Military and Base; as also into *Intrinsic* and *Extrinsic*. *Intrinsic* Service they reckon due to the Capital Lord of the Mannor. Service is again divided into *Frank* and *Base*, the one is termed *Liberum Servitium*, the other *Villenagium*. It is also divided into *Continual* or *Annual*, and into *Casual* or *Accidental*; the former being the *Seisin* of Rent, and the latter *Seisin* of Relief.

**SERVICE**, in a legal Sense, is a Right by which one Thing is subject to another Thing or Person. And of these some are,

**SERVICES Predial** or *Real*, which are *Rights* that one Estate sometimes owes another: And these *Predial* Services they reckon to be some *Rustical* or *Rural*, such as the Right of riding or walking, or going with a Carriage through another Man's Ground; the Right of drawing Water, or bringing it through his Ground, &c. And some Services are calling *Urbanæ*, which are the Rights that are preferred to Men's Houses, built contiguous to one another, &c.

**SERVICES personal**, are those *Services* which are due from a Thing to a Person; and of these they account three by Name, viz. *Usufruct*, *Use*, and *Habitation*; but there are very many and various ones which have no distinct Names.



**SERVITORS** of *Bills*, are such Servants or Messengers of the Marshal of the *King's-Bench*, as were sent abroad with Bills or Writs, to summon Men to that Court. They are now commonly called *Tip-slaves*.

**SERVIENTIBUS**, are certain Writs touching Servants, and their Masters, violating the Statutes made against their Abuses.

**SERVITUS** *acquittandis*, is a Writ Judicial, that lies for one distrained for Services to *F.* who owes and performs to *R.* for the Acquittal of such Services.

**SERUM**, is a watery, thin, yellowish, and saltish Humour, which consists chiefly of Water, with a moderate Quantity of Salt, and a little Sulphur: The Use of it is to be a Vehicle to the Blood: And this is that watery Part that separates from the Blood in the Vessel, after any Person is let Blood. A small Heat will coagulate it.

**SESAMOIDEA** *Offa*, are sixteen, nineteen, twenty, and sometimes more little ones, so called from the likeness they have to *Sesamum* Seeds, which are found in the Joints of the Hands and Feet.

The Use of these Bones, which are placed at the Articulations of the Bones of the Fingers and Toes, is, that they may serve as so many Pullies about which the Tendons pass, at some distance from the Centre of the Articulation, whereby the Directions of the Motions of these Tendons are kept always at the same distance from the Centre of Motion of the Articulation.

**SESQUIALTER**, in *Musick*. See *Time*.

**SESQUIALTERAL** *Proportion*, is when any Number or Quantity contains another once and an half, and the Number so contained in the Greater, is said to be to it in *subsesquialteral Proportion*.

**SESQUIDITONUS**, in *Musick*, a Concord which results from the Sounds of two Strings. The Vibration of which, in equal Times, are to each other in the Ratio of 5 to 6.

**SESQUIQUADRATE**, an Aspect or Position of the Planets, when at the Distance of four Signs and an half, or 135 Degrees from each other.

**SESQUIQUINTILE**, an Aspect of the Planets, when 108 Degrees distant from each other.

**SESQUITERTIAL** *Proportion*, is when any Number or Quantity contains another once and one third.

**SESSIONS**, is a sitting of Justices in Court upon Commission, as the *Sessions of Oyer and Terminer*, *Quarter-Sessions*, otherwise called *General-Sessions*; opposite whereto, are *Especial*, otherwise called *Privy-Sessions*, which are procured upon some special Occasion, for the more speedy dispatch of Justice.

*Sessions of Parliament*, is a *Sessions* which continues 'till it be prorogued or dissolved.

**SETACEUM**, is when the Skin of the Neck is taken up and run through with a Needle; and the Wound afterward kept open by Bristles, a Skean of Silk, &c. which is after moved to and fro, to give vent to the Humours that are ill disposed in that Part. 'Tis also called *Seton* and *Setum*.

**SETON**, or *Setum*. See *Setaceum*.

**SET**, when the Seamen observe on what Point of the Compass the *Sun*, *Land*, &c. bears, they call it, *Setting* the *Sun*, or *Land*, by their Compass.

**SETTLE** a *Deck*, is the Word at Sea for taking a Deck lower than it was at first, which they call settling a Deck.

**SEVERAL** *taile*, is that whereby Land is given or entailed severally, to two Men and their Wives, and to the Heirs of their Bodies begotten; the Donees have joint Estate for their two Lives, and yet they have *several* Inheritance, because the Issue of the one shall have his Moiety, and the Issue of the other the other Moiety.

**SEVERAL** *Tenancy*, is a Plea or Exception taken to a Writ that is laid against two as joint, which are *several*.

**SEVERANCE**, is the singling or severing of two, or more, that are joined in one Writ.

For Example; If two join in a Writ *de libertate probanda*, and the one afterward be Non-suit: Here *Severance* is permitted; so that notwithstanding the Non-suit of the one, the other may severally proceed.

There is also *Severance* of the Tenants in an Assize, when as one, or two, or more Disseisors appear upon the Writ, and not the other.

As also *Severance* in *Attaints*, and *Severance* in *Debt*, where two or more Executors are named Plaintiffs, and the one refuses to prosecute.

*Severance* of Corn, is the cutting and carrying it off from the Ground; and sometimes the setting out the Tythe from the rest of the Corn, is called *Severance*.

**SEW**, when a Ship at low Water comes to lie on the Ground, and to lie dry, they say *she is sewed*; and if she be not quite left dry, they say, *she sews* to such a Part.

**SEWERS**, are Passages, Canals, or Gutters to carry Water into the Sea, or some River. And therefore the Commissioners of the *Sewers* are such Persons, as by Authority under the Great Seal of *England*, do see Ditches and Drains in Marshes and Fenny-places, well kept and maintained for the better preserving the Grass upon the Land for feeding of Cattle, &c. by conveying the Water off the Ground into the Sea, or River.

**SEXAGENARY**, *Sexagenarius*, of or pertaining to the Number Sixty.

**SEXAGENARY** *Tables*, were Tables contrived (formerly) of Parts proportional, where, by Inspection, you may find the Product of two *Sexagenaries* to be multiplied, or the Quotient of two that are to be divided, &c.

**SEXAGESIMAL** *Fractions*, or *Sexagenaries*, are such as have always 60 for their Denominator: There were anciently no others used in Astronomical Operations; and they are still retained in many Cases; tho' *Decimal Arithmetick* begins to grow in Use now in Astronomical Calculations.

In these Fractions (which some call *Astronomicals*) the Denominator is usually omitted, and the Numerator only written down: Thus,

$$4^{\circ}, 59', 32'', 50''', 16''''.$$

Is to be read, 4 Degrees, 59 Minutes, 32 Seconds of a Degree, or 60th Parts of a Minute, 50 Thirds, 16 Fourths, &c.

The Ancients, before the introducing of Algorithm by the Numeral Figures now in use (finding it troublesome to express and manage Fractions of diverse Denominators, especially when they are to be expressed by great Numbers; and troublesome also to express and manage Integers, when they happen to be great Numbers) though fit to divide an Integer into 60 Parts, which they call'd λεπτά, which now we call Minutes, or Scruples; and each



each of these into 60 Parts, which they called Seconds, and (if there were yet need of greater Exactness) each of these into 60 Thirds; and each of these into as many Fourths; and so onward, as far as there was Occasion, which they called Sexagesims, or sexagesimal Parts.

And (to avoid great Numbers) a Collection of sixty Integers they called a Sexagene; and sixty of such, a second Sexagene; and sixty of these a third; and so onward, as there was occasion.

Thus, for  $\frac{1}{4}$ , the fourth Part of an Integer (be it Hour, Day, Degree, or whatever else) they put 15' (that is 15 Minutes); for  $\frac{1}{8}$ , they put 7' 30", (that is, 7 Minutes and 30 Seconds); which is exactly the same in Value: And for  $\frac{1}{7}$ , (because this cannot be exactly express'd in a Sexagesm) they would put 8', (which is pretty near, but somewhat too little) or 9', (which is yet nearer, but somewhat too much) or (if these be not exact enough for the present Purpose) 8' 34", or 8' 34" 17''; or yet more accurately, if need be, 'till they come to so much Exactness, as that the small remaining Difference might safely be neglected.

And such Sexagesims were used not only by *Ptolemy* (by whom they seem to have been first introduced) and other *Greek* Authors, but by the *Arabs* also (in Imitation of *Ptolemy*) and are continued in Use with us to this Day.

So for 227015 (which is the Number of Days whereby the *Arabic* Years of the *Hegira* began later than our Account by the Years of our Lord) they put 1''' 3" 3' 55°; that is, 1 third Sexagene, 3 second Sexagenes, 3 first Sexagenes, and 35 Days. And this Account we meet with in the *Alphonfine* Tables, and (of later Times) in those of *Lanfrbergius*.

And for the better expediting the Work of Multiplication and Division in these Sexagesims and Sexagenes, they had a Table for that purpose, in such Form as this.

$$1 \text{ By } \left\{ \begin{array}{l} 1 \\ 2 \\ 3 \\ 4 \\ \text{\&c.} \end{array} \right\} \text{ makes } \left\{ \begin{array}{l} 0 \ 1 \\ 0 \ 2 \\ 0 \ 3 \\ 0 \ 4 \\ \text{\&c.} \end{array} \right\}$$

$$5 \text{ by } \left\{ \begin{array}{l} 5 \\ 6 \\ 7 \\ 8 \\ \text{\&c.} \end{array} \right\} \text{ makes } \left\{ \begin{array}{l} 0 \ 25 \\ 0 \ 30 \\ 0 \ 35 \\ 0 \ 40 \\ \text{\&c.} \end{array} \right\}$$

$$10 \text{ by } \left\{ \begin{array}{l} 10 \\ 11 \\ 12 \\ 13 \\ \text{\&c.} \end{array} \right\} \text{ makes } \left\{ \begin{array}{l} 1 \ 40 \\ 1 \ 50 \\ 2 \ 00 \\ 2 \ 10 \\ \text{\&c.} \end{array} \right\}$$

$$11 \text{ by } \left\{ \begin{array}{l} 11 \\ 12 \\ 13 \\ 14 \\ \text{\&c.} \end{array} \right\} \text{ makes } \left\{ \begin{array}{l} 2 \ 1 \\ 2 \ 12 \\ 2 \ 23 \\ 2 \ 34 \\ \text{\&c.} \end{array} \right\}$$

$$30 \text{ by } \left\{ \begin{array}{l} 30 \\ 31 \\ 32 \\ 33 \\ \text{\&c.} \end{array} \right\} \text{ makes } \left\{ \begin{array}{l} 15 \ 0 \\ 15 \ 30 \\ 16 \ 00 \\ 16 \ 30 \\ \text{\&c.} \end{array} \right\}$$

$$50 \text{ by } \left\{ \begin{array}{l} 50 \\ 51 \\ 52 \\ 53 \\ \text{\&c.} \end{array} \right\} \text{ makes } \left\{ \begin{array}{l} 41 \ 40 \\ 42 \ 30 \\ 43 \ 20 \\ 44 \ 10 \\ \text{\&c.} \end{array} \right\}$$

And so onwards, as far as 60 by 60, makes 60 00.

Which Tables they contracted into a square or triangular Form, extending from 1 to 60; of like nature with what we call the *Pythagorical Table* for Multiplication, extending from 1 to 10.

Such a Sexagenary Table there is (or should be, if not torn out) in *Blundevil's Exercises*, with a Description, and Directions for the use of it; first published about the Year 1600, or sooner (for it is mentioned in the Preface to his Theories, published in the Year 1602, as having been then received with good Approbation) and re-printed a seventh time in the Year 1636. And the like in other Writers of Astronomical or Sexagesimal Fractions.

And then they had other Tables or Rules to determine the Denomination of the Product; as thus, Multiplication of

$$\text{Integers into } \left\{ \begin{array}{l} \text{Primes} \\ \text{Seconds} \\ \text{Thirds} \\ \text{Fourths} \\ \text{\&c.} \end{array} \right\} \text{ makes } \left\{ \begin{array}{l} \text{Primes} \\ \text{Seconds} \\ \text{Thirds} \\ \text{Fourth} \\ \text{\&c.} \end{array} \right\}$$

$$\text{Primes into } \left\{ \begin{array}{l} \text{Primes} \\ \text{Seconds} \\ \text{Thirds} \\ \text{Fourths} \\ \text{\&c.} \end{array} \right\} \text{ makes } \left\{ \begin{array}{l} \text{Seconds} \\ \text{Thirds} \\ \text{Fourths} \\ \text{Fifths} \\ \text{\&c.} \end{array} \right\}$$

$$\text{Seconds into } \left\{ \begin{array}{l} \text{Seconds} \\ \text{Thirds} \\ \text{Fourths} \\ \text{Fifths} \\ \text{\&c.} \end{array} \right\} \text{ makes } \left\{ \begin{array}{l} \text{Fourth} \\ \text{Fifths} \\ \text{Sixths} \\ \text{Sevenths} \\ \text{\&c.} \end{array} \right\}$$

The Sum of all which Particulars, are equivalent to this one General, the Exponent of the Product (that is, of the last Part thereof) is equal to the Exponent of both the Factors put together, as 10' by 11" makes 1' 50''; and 10' by 12' makes 2' 0'', &c. So 10" by 10" makes 1". 40'', &c.

My meaning is, that such Tables they had (expressed in Numeral Figures) of later Times, since those Figures were in use; but before, they must be expressed in such a way as this, viz.

$$\begin{array}{l} \text{II}^{\circ} \text{ into III}', \text{ makes VI}'. \\ \text{III}' \text{ into IV}'', \text{ makes XII}'''. \\ \text{IV}' \text{ into III}'', \text{ makes XII}'. \end{array}$$

That is, 4 Sexagenes into 3 Seconds of the Sexagesims, makes 12 of the first Sexagesims, because  $+1-2=-1$ .

$$\text{XVI}' \text{ into X}''', \text{ makes CLX}^v; \text{ that is, II}^{iv}, \text{ XL}^v.$$

(Which they find, for Expedition, by consulting their Sexagesimal Table, as we do the Table of Multiplication; where finding XVI in the Top, and X in the Side, they have, in the Square answering to both, II, XL.)

$$\text{XLV}' \text{ into LIV}', \text{ makes XL}', \text{ XXX}''.$$

Concerning this Process, by Sexagesimal Multiplication, &c. and the Demonstration of it, we have



have a learned and accurate Treatise in the *Greek* of *Barloam* a Monk (*Barloamus Monachus*) under the Title of *Logistica* (*λογιστική*) whom *Vossius* (cap. 18. *De Scientiis Mathematicis*) placeth about the Year 1350 (but mistakes it for a Treatise of Algebra): It is published by *John Chambers* (then a Fellow of *Eton College*) with his *Latin Translation*, and Notes upon it, in the Year 1600, encouraged thereunto by Sir *Henry Savile*, who chanced to light on a *Greek Manuscript* thereof abroad, and did himself, from thence, transcribe it.

But this way of Multiplication and Division in Sexagesimals, proves so perplex and troublesome (notwithstanding such a Table at Hand) that since the *Indian Figures* came in use, whereby we may with more convenience manage great Numbers) it is thought less troublesome (when there is occasion to multiply or divide) to reduce all to the lowest Denomination; and then, having performed that Work (of Multiplication or Division, or both) to reduce it back again to the several Denominations.

As for Instance; Supposing the Lunar Month of Conjunction (from New Moon to New Moon) according to the Moon's middle Motion, to be 29 D. 12 H. 44' 3" 10" *Proximè*; and I would compute how much the Moon moves from the Sun in 6 D. 5 H. 14' 16" 35". I know well that there be many Astronomical Tables computed to expedite such Operations (which here I do not meddle with) but without such Preparatory Tables, my Work must stand thus:

If 29 D. 12 H. 44' 3" 10" (that is, 11' 48 H. 44' 3" 10") give 360 Deg. (that is, 6' 10 D. Sexagenes of Degrees) then 6 D. 5 H. 14' 16" 35" (that is, 2' 29 H. 5' 14' 16" 35") will give how much?

Now, if I were to work it by the Sexagesimal Tables of Multiplication, the Work would be so perplex, that I will not here repeat it; and therefore it is thought better to reduce the first and third Numbers to the lowest Denomination, that is (here) to third Scruples.

| D. H. ' " "    | D. H. ' " "     |
|----------------|-----------------|
| 29 12 44 3 10  | 6 5 14 16 35    |
| × 24           | × 24            |
| 116            | 144             |
| 58             | + 5             |
| 12             | 149 14' 163" 5" |
| 708 44' 3" 10" | × 60            |
| × 60           | 8940            |
| 42480          | + 14            |
| + 44           | 8954' 16" 35"   |
| 42524' 3" 10"  | × 60            |
| × 60           | 537240          |
| 2551440        | + 16            |
| + 3            | 537256" 35"     |
| 2551443' 10"   | + 60            |
| × 60           | 32235360        |
| 153086580      | + 35            |
| + 10           | 32235395"       |
| 153086590"     |                 |

And then the Work will stand thus.

If 153086590 Thirds give 360 Degrees;

Then 32235395 Thirds, give how many Degrees?

Where multiplying the third Number by the second, and dividing by the first, I shall have the Number of Degrees sought in Integers, with the common Fraction annexed; which being reduced to Sexagesimals, will give the Answer in Degrees, Minutes, Seconds, &c. Or I might have reduced the 360 Degrees into Thirds also (which must have been done, if to these Degrees there had been annexed first, second, and third Minutes) and then the Answer had been in *third Minutes*; and these to be reduced to Degrees, Minutes, &c.

Which Operation, tho' it be troublesome enough, is yet more expedite, than by the Sexagesimal Multiplication and Division, since the Time that we have learned (by help of the Numerical Figure) to manage great Numbers, which in *Ptolemy's* Time were not in use.

And in like manner, whatever other come to be so multiplied.

According to this Sexagesimal Method, *Ptolemy* divides the Radius, or Semi-diameter of a Circle, into 60 Parts (and consequently the whole Diameter into 120) and each of those Parts into 60 Minutes, and each of those into 60 Seconds, and so forward, as far as Occasion requires. And accordingly, the Arch answering to such a Chord; (that is, the sixth Part of the Circumference, whose Chord equals the Radius) into 60 Deg. and consequently the whole Circumference into 360 Deg. and each of these Degrees into Minutes, Seconds, &c. by a continual Sexagenary Division.

And consonant hereunto, he makes his Table of Chords of Subtenses (in such Parts, Minutes, and Seconds) answering the several Arches in a Circle.

Instead of which, the *Arabs* or *Saracens* have introduced (as more expedient) their Table of Sines (or half Chords of the double Arch) expressed in like manner by Sexagesimal Parts.

Which they did rather in Imitation of *Ptolemy*, than that they were necessitated so to do, having the Use of Numeral Figures as we have, which *Ptolemy*, and others of the Ancients, had not.

But *Arzachel* therein differs thus far from *Ptolemy*, that he divides his Diameter into 300 Parts, which *Ptolemy* divides but into 120, and hath therefore less need of Subdivisions.

The reason why the Ancients did thus reduce their ordinary Fractions all to one kind of Denomination, was; to avoid the Trouble which would arise from the different Denomination of Fractions, which (when they had not the Helps that now we have) would be very great; and therefore chose to admit of Approximations, many times, instead of accurate Equalities.

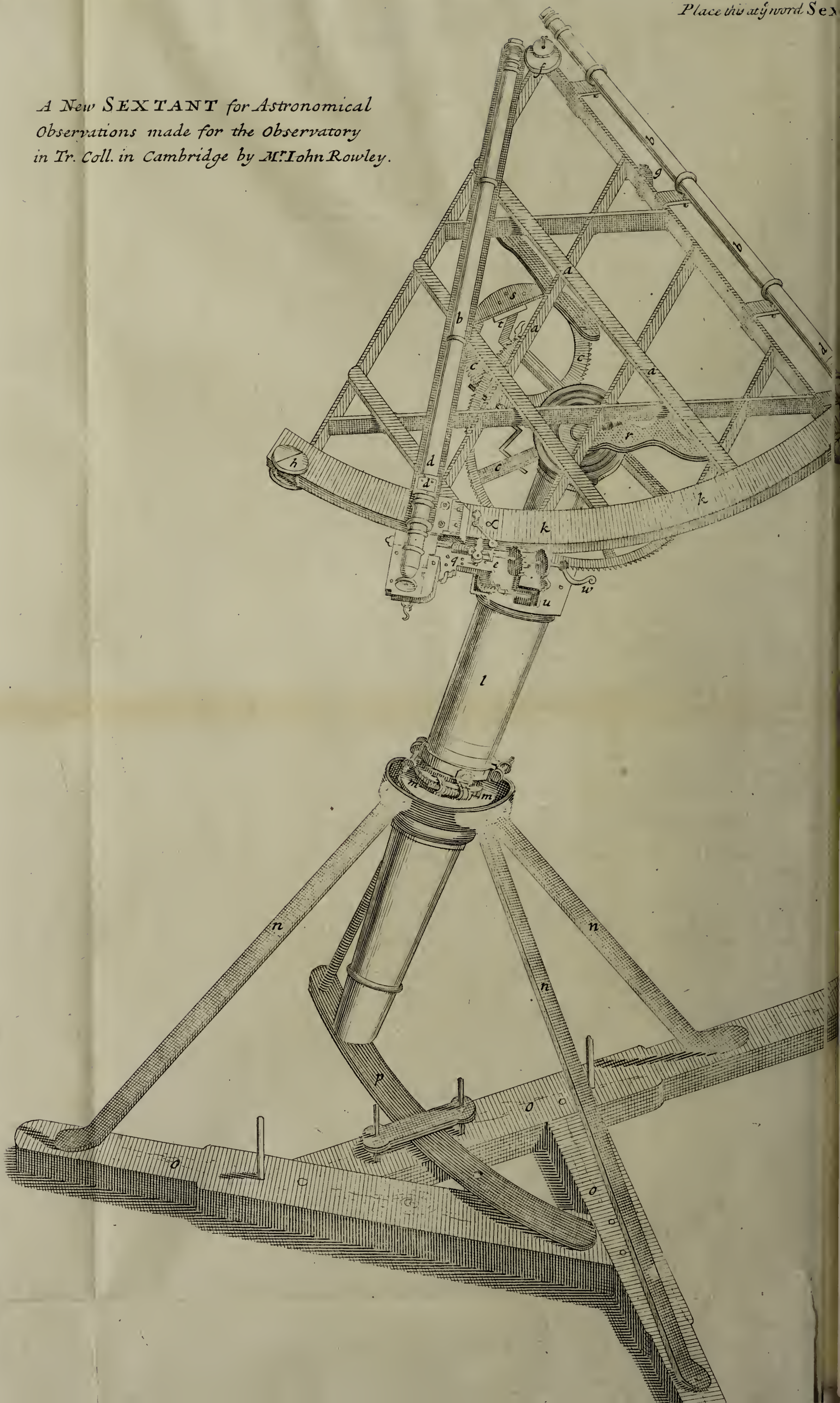
And why they chose the Number 60, rather than any other Number, was, because if they had made use of 12, or such other small Number, they would be put upon a necessity of the more Subdivisions, and a Number much greater than this they could not well manage (there being, even in this, Trouble enough) and of Numbers about this Bigness, this was thought most convenient, as being most capable of exact Divisions, without being put to the Necessity of Approximations or Subdivisions; admitting, for Divisors, the six first







*A New SEXTANT for Astronomical  
Observations made for the Observatory  
in Tr. Coll. in Cambridge by M<sup>r</sup>. John Rowley.*





Numbers, 1, 2, 3, 4, 5, 6, (which none less than it can do) and as many more answering to them, 10, 12, 15, 20, 30, 60 (that is Twelve in all) there being no Number less than it, admitting of so many Divisors; nor can any, greater than it, admit of more, which is not at least twice as great; which cannot be said again of any greater Number, 'till we come to 360. And this is that which is made the Number of Degrees in the whole Circle.

And this Division of Integers into Sexagesims (Minutes, Seconds, Thirds, &c.) especially in the Parts of Arches, Angles, Time, and Motion; the *Arabs* have retained in Imitation of the *Greeks* (or *Egyptians*) and we from them, even to this Day. *Wallis's Algebra, Chap. VII.*

SEXANGLE, in Geometry, is a Figure consisting of six Angles.

SEXTANS, is the sixth Part of any thing, thus: There is an Astronomical Instrument called a *Sextant*, as being the sixth Part of a Circle. This hath a graduated Limb, and is used like a Quadrant.

SEXTANT. *The Description of a new Sextant, lately made for the Observatory in Trinity-College, Cambridge, by Mr. John Rowley.*

*a a a* Iron Bars set edge and flat-ways, composing and framing the Body of the *Sextant*, whose Radius is five Foot.

*b b* Are two Telescopes, the one fix'd on the right Edge of the *Sextant*, from which the Divisions on the Limb are numbred, and the other moveable with the Index.

*c c* Two large Brass Semi-circles on the Back-side of the *Sextant*, which by Nuts and Screws can bring the Instrument into any Position in any Plane, *Horizontal, Vertical, or Reclining.*

*dd* The Place of the Cross Hairs within the Telescope, which are made to be moved (from the Out-side) for the better adjusting them to the Instrument.

*e* The Revolution-Work, which proves the Index gradually (by the Help of a Screw) and sensibly shews its Progress, to the thousandth Part of an Inch.

*f* The Centre of the Instrument, from which a Plumb-Line falling on the Line (*i*) at the lower End of the right Edge of the *Sextant*, takes Distances from the Zenith.

*g* Is another Centre, from which a Plumb-Line falling on the Line (*b*), takes Altitudes from the Horizon.

*k* Is the Brass Limb of the Instrument, being diagonally divided into every five Minutes, and by proportional Parts on the Index, shews every ten Seconds.

*l* Is a *Lignum-Vitæ* Axis, upon which the *Sextant* turns; and is made so, as to be plac'd either parallel to the Axis of the Equator, or of the Horizon.

*m m* Is a Contrivance by the Motion of Wheels, Nuts and Screws, so as to make the whole *Sextant* move answerably to the apparent Diurnal Motion of the Heavens.

*n n n* Three strong Iron Feet, fix'd to an Iron Collar, to hold the aforesaid Axis (*l*).

*ooo* Are three Pieces of Timber, to which the Iron Feet are screw'd, and which serve to compleat the Pedestal of the Instrument.

*p* An Arch of Iron, which shifts the *Axis* (*l*) to its Parallelism with either the Axis of the Equator or Horizon.

*The Limb of this noble Instrument is very accurately divided, diagonally, and by the way of unequal Divisions, used by Hevelius; so that the Angle may be taken either of those Ways, as well as be found by the Revolution-Work.*

SEXTAR of Wheat or other Corn (from *Sextarius*) was that Quantity anciently which we now call a *Quarter*, containing a Bushel. In some Countries 'tis called a *Seame*.

SEXTILE, the Position or Aspect of the Planets, when at 60 Degrees distant, or at the Distance of two Signs from one another; and is marked thus \*.

SGRAFIT, *Sgrafficiata*, probably of [*σκαφω*, Gr.] a Method of Painting in Black and White only, not only in *Fresco*, yet such as will bear the Weather. It is both the Design and Painting all in one.

SHACKLES, aboard a Ship, are those oblong Iron Rings, and bigger at one End than at the other, with which the Ports are shut fast, by thrusting the wooden *Bar of the Port* through them. There are also a sort of Shackles to lift the Hatches up with, of the former Figure, but smaller; they are fastened at the Corners of the Hatches.

SHADOW, *Shade*, a Plan where the Light is weakened by the Interposition of some opaque Body before the Luminary. The Shadow of Yew, Cypress, and Walnut-Tree, are held dangerous to Men; the Shadow of Ash is held deadly to Serpents, for which reason Serpents are never found under its Shade. The Doctrine of Shadows makes a considerable Article in Optics and Geography, and is the Foundation of Dialling.

Shadow, in Optics, is a Privation of Light, by the Interposition of an opaque Body: But as nothing is seen but by Light, a meer Shadow is invisible. When therefore we say, we see a Shadow, 'tis partly that we see Bodies placed in the Shadow, and illuminated by Light, reflected from collateral Bodies; and partly, that we see the Confines of the Light.

If the opaque Body, that projects the Shadow, be perpendicular to the Horizon, and the Place 'tis projected on, be horizontal, the Shadow is called a right Shadow; such are the Shadow of Men, Trees, Buildings, Mountains, &c. If the opaque Body be placed parallel to the Horizon, the Shadow is called a versed Shadow; as the Arms of a Man stretched out, &c.

#### *Laws of the Projection of Shadows from opaque Bodies.*

1. Every opaque Body projects a Shadow in the same Direction with its Rays; that is, towards the Part opposite to the Light. Hence, as either the Luminary, or the Body changes Place, the Shadow likewise changes.

2. Every opaque Body projects as many Shadows as there are Luminaries to enlighten it.

3. As the Light of the Luminary is more intense, the Shadow is the deeper. Hence the Intensity of the Shadow is measur'd by the Degrees of Light that Space is deprived of.

4. If a luminous Sphere be equal to an opaque one it illumines, the Shadow this latter projects will be



be a Cylinder; and, of consequence, will be propagated still equal to itself; to whatever Distance the Luminary is capable of acting; so that, if it be cut in any Place, the Plane of the Section will be a Circle equal to a great Circle of the opake Sphere.

5. If the luminous Sphere be greater than the opake one, the Shadow will be conical. If therefore the Shadow be cut by a Plane parallel to the Base, the Plane of the Section will be a Circle, and that so much the less, as it is at a greater Distance from the Base.

6. If the luminous Sphere be less than the opake one, the Shadow will be a truncated Cone; consequently, it grows still wider and wider; and therefore, if cut by a Plane parallel to the Section, that Plane will be a Circle so much the greater, as 'tis further from the Base.

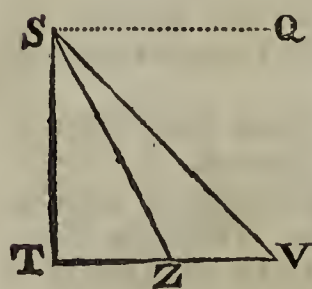
7. To find the Length of the Shadow, or the Axis of the shady Cone, projected by a less opake Sphere, illuminated by a larger; the Diameters of the two, as  $CD$ , and  $IN$ ; and the Distance between their Centres  $GM$  being given.

Draw  $FM$  parallel to  $CH$ ; then will  $IM = CF$ ; and therefore  $FC$  will be the Difference of the Semidiameters  $GC$  and  $IM$ ; consequently, as  $FG$ , the Difference of the Semidiameters, is to  $CM$ , the Distance of the Centres; so is  $CF$ , the Semidiameter of the opake

Sphere, to  $MH$ , the Distance of the Vertex of the shady Cone, from the Centre of the opake Sphere. If then the Ratio of  $PM$  to  $MH$  be very small; so that  $MH$  and  $PH$  do not differ very notably,  $MH$  may be taken for the Axis of the shadowy Cone; otherwise the Part  $PM$  must be subtracted from it; which to find, seek the Arch  $LK$ : For this subtracted from a Quadrant, leaves the Arch  $IQ$ ; which is the Measure of the Angle  $IMP$ . Since then, in the Triangle  $IMP$ , which is rectangular at  $P$ ; besides the Angle  $IMQ$ , we have the Side  $IM$ ; the Side  $MP$  is easily found by plain Trigonometry. *E. gr.* If the Semidiameter of the Earth  $MI = 1$ , the Semidiameter of the Sun, according to *Ricciolus*, will be  $= 33$ ; and therefore  $GF = 32$ ; and of Consequence  $MH = 228\frac{1}{8}$ ; since then  $MP$  is found by Calculation to bear a very small Ratio to  $MH$ ,  $PH$  is found to be  $288\frac{1}{2}$  Semi-diameters of the Earth.

Hence, as the Ratio of the Distance of the opake Body, from the luminous Body  $CM$ , to the Length of the Shadow  $MH$ , is constant; if the Distance be diminished, the Length of the Shadow must be diminished likewise, consequently the Shadow continually decreases as the opake Body approaches the Luminary.

8. To find the Length of the Shadow projected by an opake Body  $TS$ , the Altitude of the Luminary; *E. gr.* of the Sun above the Horizon, *viz.* the Angle  $SVT$ , and that of the Body being given, since in the Rectangle Triangle  $STV$ , we have given the Angle  $V$ , and the Side  $TS$ ; the Length of the Shadow  $TV$  is had by Trigonometry.



Thus, suppose the Altitude of the Sun 37 Deg. 40 Minutes, and the Altitude of a Tower 187 Feet,  $TV$  will be found  $241\frac{1}{2}$  Feet.

9. The Length of the Shadow  $TV$ , and the Height of the opake Body  $TS$  being given, to find the Altitude of the Sun above the Horizon.

Since, in the Rectangle Triangle  $STV$ , the Sides  $TV$  and  $TS$  are given; the Angle  $V$  is found thus: As the Length of the Shadow  $TV$  is to the Altitude of the opake Body  $TS$ , so is the whole Sine to the Tangent of the Sun's Altitude above the Horizon. Thus, if  $TS$  be 30 Foot, and  $TV$  45 Min.  $TVS$  will be found 33 Deg. 41 Min.

10. If the Altitude of the Luminary; *E. gr.* The Sun above the Horizon  $TVS$ , be 45 Deg. the Length of the Shadow  $TV$  is equal to the Height of the opake Body.

11. The Lengths of the Shadows  $TZ$  and  $TV$  of the same opake Body  $TS$ , in different Altitudes of the Luminary, are as the Co-tangents of those Altitudes.

Hence, as the Co-tangent of a greater Angle is less than that of a less Angle, as the Luminary rises higher, the Shadow decreases; whence it is, that the Meridian Shadows are longer in Winter than in Summer.

12. To measure the Altitude of any Object: *E. gr.* A Tower  $AB$ , by means of its Shadow projected on a Horizontal Plane.

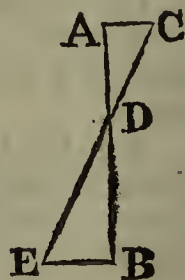
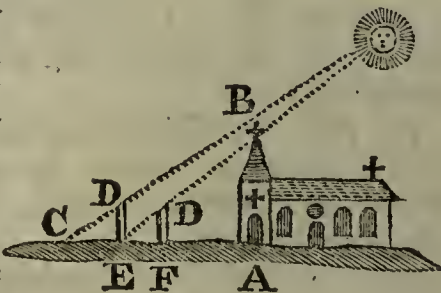
At the Extremity of the Shadow of the Tower  $C$ , fix a Stick, and measure the Length of the Shadow  $AC$ ; fix another Stick in the Ground of a known Altitude  $DE$ , and measure the Length of the Shadow thereof  $EF$ . Then, as  $EF$  is to  $AC$ , so is  $DE$  to  $AB$ . If, therefore,  $AC$  be 45 Yards, and  $ED$  5 Yards;  $AB$  will be 327 Yards.

13. The Shadows of equal opake Bodies have their Length proportionable to their Distances from the same Luminaries equally high. Hence, as the Opake approaches to the Luminary, or the Luminary to the opake Body, the Length of the Shadow is increased; and as either of them recedes, is diminished. Hence, from the different Lengths of Shadows of the same opake Bodies at the same Height of the Sun, Moon, *Jupiter*, *Venus*, &c. we may gather their different Distances from the Earth, tho' not accurately enough for Astronomical Purposes.

14. The right Shadow is to the Height of the opake Body, as the Co-sine of the Luminary to the Sine.

15. The Altitude of the Luminary being the same in both Cases, the opake Body  $AC$  will be to the versed Shadow  $AD$ , as the right Shadow  $EB$  to its opake Body  $DB$ .

Hence, 1. The opake Body is to its versed Shadow, as the Co-sine of the Altitude of the Luminary to its Sine: consequently, the versed  $AD$  is to its opake Body  $AC$ , as the Sine of the Altitude of the Luminary to its Co-sine. 2. If  $DB = AC$ , then will  $DB$  be a mean Proportional





onal between  $EB$  and  $AD$ ; that is, the Length of the opake Body is a mean Proportional between its right Shadow and verfed Shadow, under the fame Altitude of the Luminary. 3. When the Angle  $C$  is 45 Deg. the Sine and Co-sine are equal; and therefore the verfed Shadow equal to the Length of the opake Body.

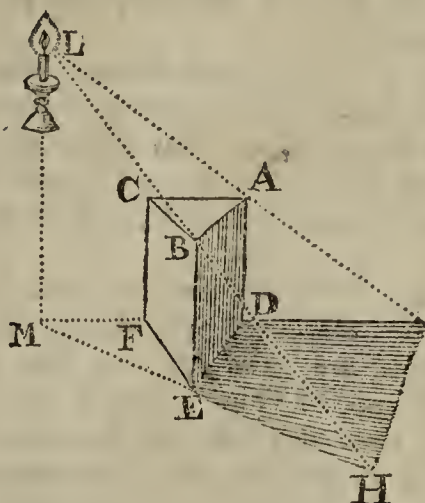
16. A right Sine is to a verfed Sine of the fame opake Body, under the fame Altitude of the Luminary, in a duplicate Ratio of the Co-sine, to the Sine of the Altitude of the Luminary.

Right and verfed Shadows are of considerable Use in Measuring; as by their means we can commodiously enough measure Altitudes, both accessible and inaccessible, and that too when the Body does not project any Shadow. The right Shadows we use when the Shadow does not exceed the Altitude; and the verfed Shadows, when the Shadow is greater than the Altitude. On this Footing, is made an Instrument called the Quadrant, or Line of Shadows, by means whereof the Ratios of the right and verfed Shadow of any Object, at any Altitude, are determined. This Instrument is usually added on the Face of the Quadrant.

*Shadow, in Geography.* The Inhabitants of the Globe are divided, with respect to their Shadows, into *Ascii*, *Amphiscii*, *Heteroscii*, and *Periscii*. The first are such as at a certain Season of the Year have no Shadows at all, while the Sun is in the Meridian. The second are such, whose Meridian Shadow, at one Season of the Year looks to the North, and at another to the South. The third are such, whose Shadows constantly tend either to the North or South. The last are those, whose Shadows, in one and the same Day, successively tend to all the Points.

*Shadow in Perspective.* The Appearance of an opake Body, and a luminous One, whose Rays diverge (*E. gr.* as Candle, Lamp, &c.) being given; To find the just Appearance of the Shadow according to the Laws of Perspective. The Method is this; From a luminous Body, which is here consider'd as a Point, let fall a Perpendicular to the perspective Plane or Table; *i. e.* Find the appearance of a Point upon which a Perpendicular, drawn from the Middle of the Luminary, falls on the perspective Plain; and from the several Angles, or raised Points of the Body, let fall Perpendiculars to the Plane. These Points whereon these Perpendiculars fall, connect by right Lines with the Point upon which the Perpendicular, let fall from the Luminary, falls; and continue the Lines to the Side opposite to the Luminary. Lastly, through the raised Points draw Lines through the Centre of the Luminary, intersecting the former; the Points of Intersection are the Terms, or Bounds, of the Shadow.

*E. gr.* Suppose it required to project the Appearance of the Shadow of a Prism,  $ABCFED$ , Scenographically delineated; Since  $AD$ ,  $BE$ , and  $CF$  are perpendicular to the Plane, and  $LM$  is likewise perpendicular to the same (for the Luminary is given, if its Altitude  $LM$  be given); Draw the right Lines  $CM$  and  $HM$ , through the Points  $DE$ . Through the raised Points  $A$  and  $B$ , draw the right Line  $CL$  and  $HL$ , intersecting the former on  $C$  and  $H$ . Since the Shadow of the right Line  $AD$  terminates in  $C$ , and the Shadow of the right Line  $BE$  in  $H$ ; and the Shadows of all the other right Lines conceived in the given Prism are



comprehended within these Terms,  $CDEH$  will be the Appearance of the Shadow projected by the Prism.

**SHAFT**, is the hollow Entrance into a Mine which is *funk* or *dug* to come at the Ore. In the Tin-Mines, after this is funk about a Fathom, they leave a little long square Place, which is called a *Shamble*.

**SHAFT of a Column**, is the Body of it, so called from its Straightness, but by Architects more frequently the *Fust*.

**SHALLOP**, is a small, light Vessel with only a small Main-Mast and Fore-Mast, and Lugg-Sails, to hale up and let down upon Occasion: They commonly are good Sailors, especially the *French Chaloups*; and are often used as Tenders upon a Man of War.

**SHAMBLE.** See *Shaft*.

**SHAME**, is an Uneasiness of the Mind, upon the Thought of having done something which is indecent; or will lessen the valued Esteem which others have of us.

**SHANK**, or *Shank-Painter*, in a Ship, is a short Chain fastned under the Fore-Mast Shrouds, by a Bolt to the Ship's Side, having at the other End a Rope fastned to it. On this Shank-Painter, the whole Weight of the Aft-part of the Anchor rests, when it lies by the Ship's Side. The Rope by which it is haled up, is made fast about a Timber-head.

**SHANKER**, in *Surgery*, a malignant Ulcer, which grows and eats the Flesh, for the most Part proceeding from some Venereal Disorder.

**SHAPOURNETT**: The Heralds call a kind of Cap, which is born in some Coats of Arms, by this Name.

**SHARP**, in *Musick*, an artificial Note, or Character, in this Form ( $\sharp$ ) which being prefix'd to a Note, indicates that it is to be sung or play'd a Semi-tone, or a half Note, higher than the natural Note would have been.

**SHEATHING** of a Ship, is casing that Part of her which is to be under Water, with something to keep the Worms from eating into her Planks. 'Tis usually done by laying Tar and Hair mixt together all over the old Plank, and then nailing on thin new Boards: But this hinders a Ship's sailing; and therefore of late some have been sheathed with mill'd Lead.

'Tis very well worth trying what the new Stone-Pitch will do in this Case; if it will defend from the Worm, as perhaps it will, a Ship might be paid with it cheaper than with the Crown-Pitch; and it will not crack nor scale off as that will do, but



keep always soft and smooth. I have seen where it hath been on thirteen Months, and yet it was very black and soft.

**SHEATS** in a Ship, are Ropes bent to the Clews of the Sails; serving in the lower Sails to *Hale-aft*, or *Round-off* the Clew of the Sail: But in Top-sails they serve to *Hale-home*, as the Word is, or to hale the Clew of the Sail close to the Yard-Arm.

If the Main-sail Sheats are *haled aft*, 'tis in order to make the Ship keep by a Wind; but when the Fore-sheats are *haled aft*, 'tis that the Ship may fall off from the Wind: And if she will not do it readily, then they hale the Fore-sail (by the Sheat) flat in, as near the Ship's Sides as they can; and this they call *Flatting in the Fore-sail*. When they say, *Ease the Sheat*, they mean *Veer it*, or let it go out gently; but when the Word is, *Let fly the Sheat*, they mean, let it go all at once, and run out as fast as it can; and then the Sail will hang loose, and hold no Wind. In a very great Gust or Gale of Wind, there is another Rope bent to the Clews of the *Main-sail* and *Fore-sail*, above the Sheat Block, to succour and ease the *Sheat*, and this they call a *False-Sheat*.

*Sheats* in a Ship, also are those Planks under Water which come along her *Run*, and are closed into the *Stern-Post*: So also that Part within Board in the *Run* of the Ship, is called the *Stern-sheats*. The Seamen say, when they would have the *Sheats* of the Main or Fore-Sail haled aft, *Tally the Sheats*.

**SHEER**, or *Sheering*; the Sea-Phrase for the going of a Ship when she is not steered steadily; then they say, she *sheers*, or goes *sheering*; as they do also when she goes in and out by means of the swift running of a Tide-Gate, &c. for then being at an Anchor, they say there is Danger, lest she should *sheer home her Anchor*, or sheer ashore.

**SHEER-Hooks**, aboard a Ship, are great Hooks of Iron, sometimes used when a Ship designs to board another. They are like a Sickle, and are let into the Main-Yard-Arms, and Fore-Yard-Arms, in order to spoil, cut or tear the Enemy's Shrouds, Sails, or Rigging.

**SHEER-Shanks**, at Sea, is the Term for a kind of Knot, by which they tie up, or shorten a Runner, when 'tis too long, so that they cannot hoise in the Goods by it over the Ship's Sides. This Knot can be let loose again when they please.

**SHEERS**, so the Seamen call two Masts Yards, or Poles, set up and seized a-cross each other aloft, near the Top. This *Pair of Sheers*, as they call it, is placed below on the *Chain-Wales* of the Shrouds, and lashed fast to the Ship's Sides to keep them steady aloft. Their use is to set in, or take out a Mast; for which end, there is fastned at the same Place where they cross one another, a strong double Block with a Strap. They serve also to hoise in or out of Boats that have Masts, such Goods as are wanted to be taken in or out.

**SHELF**, is what the *Miners* (especially in the Tin-Mines) call the *Fast-Country*, by which they mean an imaginary Surface of the Earth, which at the Concussion of the Waters in the general Deluge of *Noah*, was never moved; and to the *Shelf*, they think all the *Loads* or *Mineral Veins* at first lay even and parallel; tho' after the Flood they were some elevated, some depressed, &c. And by *Shelf* now they mean that hard Surface, or Coat, of the

Earth which lies under the *Mold*, usually about a Foot deep; for they suppose, that since the Flood the Earth hath gotten a new Coat of Vegetable Earth, or such as is made by the Corruption of Vegetables and Animals.

**SHERIVE**, or *Sheriff*, *Vice-Comes*, is the Chief Officer of the King in any Shire or County. Formerly the Sheriff was chosen by the People in the County-Court by Vote, as the Knights of the Shire for Parliament now are; but now the Sheriff is nominated by the King. *Camden*, in his *Britannia*, describes this Office, and the Antiquity and Authority of this Officer. See *Co. Rep. lib. 4*. And *Spelman's Glossary* under the Word *Vice-Comes*. His Oath is extant in *Reg. Orig. fol. 331*.

**SHERIFF-Tooth**, seems anciently to have been a Tenure by the Service or Duty of providing Entertainment for the Sheriff at his County-Turns or Courts. For it appears by *Ryley's Placita Parliament. fol. 653*. That in *Derbyshire* the King's Bailiffs did formerly take Six-pence of every *Bovate* of Land, in Name of *Sheriff-Tooth*.

**SHEWING**, in Law, is to be quit of Attachments in any Court, and before whomsoever in Plaints shewed, and not avowed.

**SHIFTERS**, certain Men aboard a Man of War, who are employ'd by the Cooks to shift or change the Water in which the Flesh or Fish is put and laid for some time, in order to fit it for the Kettle.

**SHILLING**, *Solidus* in the *Latin*, is a Word of very uncertain Signification, and differs almost in every Nation. But the Word *Scylling*, or *Shilling* in *England*, never signified any thing but Five-pence with the *Saxons*, and Twelve-pence ever since. When it first went for Twelve-pence, it is hard to find; but there was no Twelve-penny Piece of that Name coined in *England* 'till 1504, and then *Stow* calls them Groats; though *Fabian* mentions them under the Name of *Shillings*. In 34 *Hen. 8*. there were Twelve-penny Pieces struck, but they were called *Testons*.

**SHINGLES**, in *Physick*, a kind of *Herpes*, called also *Military Herpes*, which consists of innumerable little Pustules, which break out in various Parts of the Body, viz. the Neck, Breast, Loins, Thighs, &c. The Place affected is something inflamed, and the Patient a little feverish.

**SHINGLES**, in *Building*, small Pieces of Wood, or quarter'd Oaken Boards saw'd to a certain Scantling, or those usually cleft to about an Inch thick at one End, and made like Wedges, four or five Inches broad, and eight or nine Inches long, for covering of Churches, Steeples, &c. instead of Tiles, Slates, &c.

**SHINGLING-Tongs** are used in the *Finery* of an Iron-Forge, to take out the *Loop*, in order to bring it under the Hammer into a *Bloom*.

**SHIP**. The Description of the several Parts and Rigging of a First Rate Ship lying at Anchor.

H. Her Hull.

- A The Cut-water.
- B The Stem.
- C The Hawse Holes.
- D The Cat-Head.
- E Waste Cloaths.
- F The Fore Chain-wale.

G The





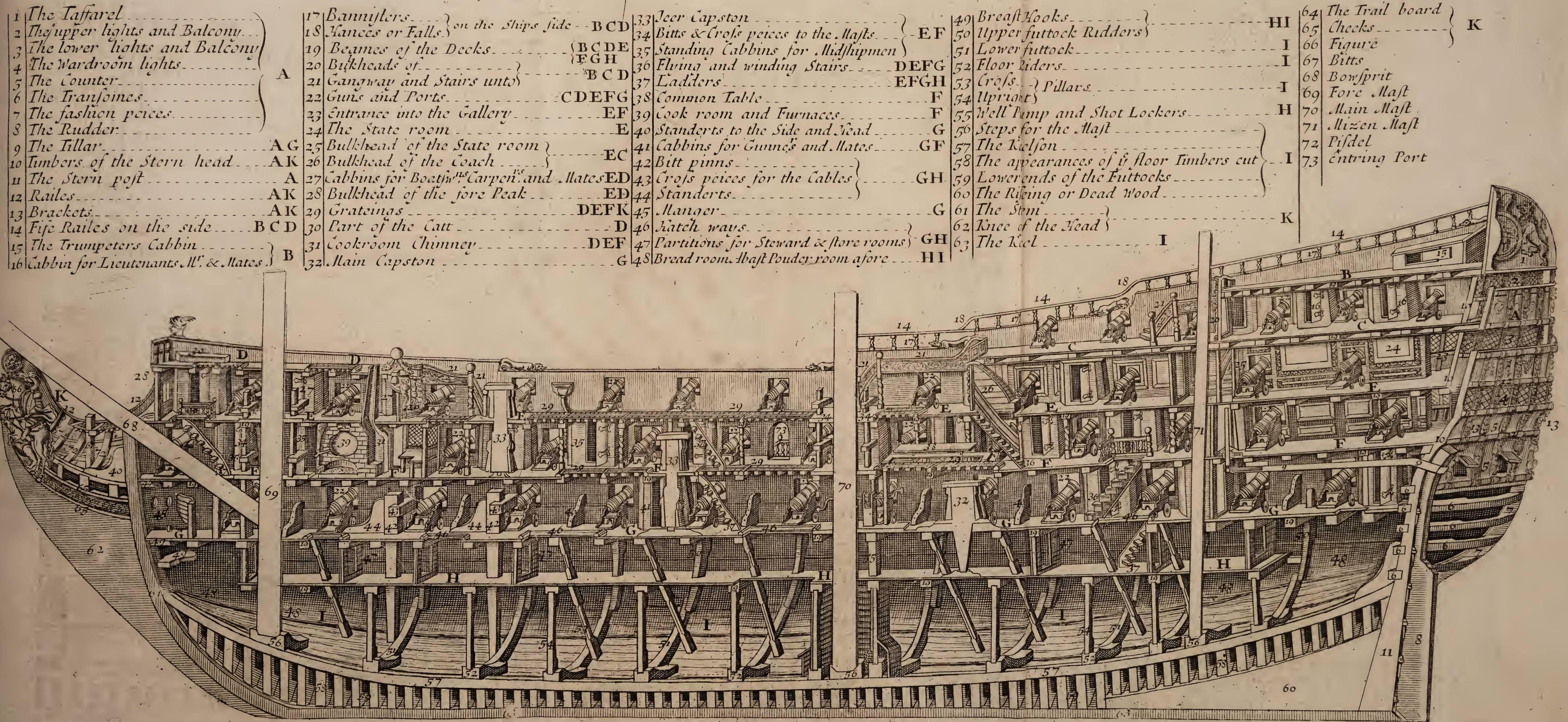






- |   |                  |   |                 |
|---|------------------|---|-----------------|
| A | The Stern abast  | F | The middle Deck |
| B | The Poop         | G | The Gun Deck    |
| C | The quarter Deck | H | The Orlop       |
| D | The Forecastle   | I | The Hold        |
| E | The upper Deck   | K | The Head        |

All particulars on either of these parts, are distinguished by numbers 1, 2, 3, &c against w<sup>ch</sup> there is placed y<sup>e</sup> letter of y<sup>e</sup> Alphabet, w<sup>ch</sup> refers to the Principal part or parts, where that particular is to be found. (Viz)



- |    |   |     |
|----|---|-----|
| 1  | The Taffarel                                    |     |
| 2  | The upper lights and Balcony                    |     |
| 3  | The lower lights and Balcony                    |     |
| 4  | The Wardroom lights                             |     |
| 5  | The Counter                                     | A   |
| 6  | The Transomes                                   |     |
| 7  | The fashion peices                              |     |
| 8  | The Rudder                                      |     |
| 9  | The Tillar                                      | AG  |
| 10 | Timbers of the Stern head                       | AK  |
| 11 | The Stern post                                  | A   |
| 12 | Railes  | AK  |
| 13 | Brackets  | AK  |
| 14 | Fife Railes on the side                         | BCD |
| 15 | The Trumpeters Cabbin                           |     |
| 16 | Cabbin for Lieutenants M <sup>r</sup> . & Mates | B   |

- |    |   |                   |
|----|---|-------------------|
| 17 | Bannisters  |                   |
| 18 | Rances or Falls   | on the Ships side |
| 19 | Beames of the Decks   | BCDE              |
| 20 | Bulkheads of  | EGH               |
| 21 | Gangway and Stairs unto                                       | BCD               |
| 22 | Guns and Ports  | CDEFG             |
| 23 | Entrance into the Gallery                                     | EF                |
| 24 | The State room  | E                 |
| 25 | Bulkhead of the State room                                    | EC                |
| 26 | Bulkhead of the Coach   |                   |
| 27 | Cabbins for Boat <sup>sm</sup> Carpen <sup>ts</sup> and Mates | ED                |
| 28 | Bulkhead of the fore Peak                                     | ED                |
| 29 | Grateings   | DEFK              |
| 30 | Part of the Catt  | D                 |
| 31 | Cookroom Chimney  | DEF               |
| 32 | Main Capston  | G                 |

- |    |                                      |      |
|----|--------------------------------------|------|
| 33 | Jeer Capston                         |      |
| 34 | Bits & Cross peices to the Masts     | EF   |
| 35 | Standing Cabbins for Midshipmen      |      |
| 36 | Flving and winding Stairs            | DEFG |
| 37 | Ladders                              | EFGH |
| 38 | Common Table                         | F    |
| 39 | Cook room and Furnaces               | F    |
| 40 | Standerts to the Side and Head       | G    |
| 41 | Cabbins for Gunnes and Mates         | GF   |
| 42 | Bitt pinns                           |      |
| 43 | Cross peices for the Cables          | GH   |
| 44 | Standerts                            |      |
| 45 | Manger                               | G    |
| 46 | Katch ways                           |      |
| 47 | Partitions for Steward & store rooms | GH   |
| 48 | Bread room, Abast Powder room afore  | HI   |

- |    |   |    |
|----|---|----|
| 49 | Breast Hooks  |    |
| 50 | Upper futtock Ridders                               | HI |
| 51 | Lower futtock                                       | I  |
| 52 | Floor Ridders                                       | I  |
| 53 | Cross Pillars                                       | I  |
| 54 | Upright   |    |
| 55 | Well Pump and Shot Lockers                          | H  |
| 56 | Steps for the Mast                                  |    |
| 57 | The Kielson   |    |
| 58 | The appearances of y <sup>e</sup> floor Timbers cut | I  |
| 59 | Lowerends of the Futtocks                           |    |
| 60 | The Riving or Dead Wood                             |    |
| 61 | The Stem  |    |
| 62 | Knee of the Head                                    | K  |
| 63 | The Kiel  | I  |

- |    |                 |   |
|----|-----------------|---|
| 64 | The Trail board |   |
| 65 | Cheeks          | K |
| 66 | Figure          |   |
| 67 | Bits            |   |
| 68 | Bow sprit       |   |
| 69 | Fore Mast       |   |
| 70 | Main Mast       |   |
| 71 | Mizen Mast      |   |
| 72 | Pisdel          |   |
| 73 | Entring Port    |   |



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Handwritten text, possibly a list or ledger, with multiple columns and rows of entries. The text is faint and difficult to read.



- G *The Main Chain-wale.*  
 H *The Mizzen Chain-wale.*  
 I *The Chest Tree.*  
 K *The Entering Port.*  
 L *The Head.*  
 M *The Gallery.*  
 N *The Tafferel.*  
 O O O *The three Peep Lanterns.*  
 P *The Ensign-Staff.*  
 Q *Its Truck.*  
 R *The Ensign, or Antient.*

Z. *The Mizzen-Mast, and Rigging.*

- 1 *The Mizzen Mast.*
- 2 *The Mizzen Yard and Sail.*
- 3 *The Mizzen Sheet.*
- 4 *The Mizzen Shrouds and Laniards.*
- 5 *The Mizzen Bow-lines.*
- 6 *The Mizzen Brayles.*
- 7 *The Geer.*
- 8 *The Mizzen Peek Halliards.*
- 9 *The Cross Jack-Yard.*
- 10 *The Lifts.*
- 11 *The Braces.*
- 12 *The Mizzen Puttock Shrouds.*
- 13 *The Mizzen-top.*
- 14 *The Mizzen-top Armour.*
- 15 *The Cap.*
- 16 *Crow-feet.*
- 17 *The Mizzen Stay and Sail.*
- 18 *The Halliards.*

## Mizzen Top-Mast and Rigging.

- 19 *Mizzen Top-Mast.*
- 20 *Its Sails furled.*
- 21 *Its Braces.*
- 22 *Its Lifts.*
- 23 *Its Shrouds.*
- 24 *Its Halliards.*
- 25 *Its Back-stay.*
- 26 *Its Bow-lines.*
- 27 *Its Sheet.*
- 28 *The Clew-lines.*
- 29 *The Stay.*
- 30 *The Cross-trees.*
- 31 *The Cap.*
- 32 *The Stump.*
- 33 *Its Stay.*
- 34 *Its Truck.*
- 35 *The Spindle.*
- 36 *The Vane.*
- 37 *The Slings of the Cross Jack-Yard.*

M. *The Main-Mast and its Rigging.*

- 38 *The Main-Mast.*
- 39 *Runners and Tackles.*
- 40 *Tackle.*
- 41 *The Main Shrouds and Laniards.*
- 42 *The Main-stay and Sail.*
- 43 *The Stay-sail Halliards.*
- 44 *The Main-Yard and Sails.*
- 45 *The Geers.*
- 46 *The Main-sheets.*
- 47 *The Main-tacks.*
- 48 48 *The Bunt-lines.*
- 49 49 *The Main Bow-lines.*
- 50 *The Main-Braces.*

- 51 51 *The Leech-lines.*
- 52 *The Main Puttock-Shrouds.*
- 53 *The Crow-foot.*
- 54 54 *The Main-lifts.*
- 55 *The Main-top.*
- 56 *The Top Armour.*
- 57 *The Top Rope.*
- 58 *The Main-Cap.*
- 59 *The Main-Yard-tackles.*

## Main Top-Mast and Rigging.

- 60 *The Main Top-mast.*
- 61 61 *Tackles.*
- 62 *The Main-top-mast Shrouds.*
- 63 *The Back-stays.*
- 64 *The Main-top-sail Halliards.*
- 65 *The Main-top-sail Stay and Sail.*
- 66 *The Main-top-sail Halliards.*
- 67 *The Main-top-sail Yard and Sail.*
- 68 *The Main-top-sail Braces.*
- 69 *The Main-top-sail Bow-lines.*
- 70 *The Main-top-sail Sheets.*
- 71 71 *The Main-top-sail Clew-lines.*
- 72 72 *The Main-top-sail Lifts.*
- 73 *The Runner.*
- 74 *The Bunt-lines.*
- 75 *The Cross-tree.*
- 76 *The Cap.*
- 77 *The Stump.*
- 78 *The Stay.*
- 79 *The Truck.*
- 80 *The Pendant.*

F. *The Fore-Mast and Rigging.*

- 81 *The Fore-Mast.*
- 82 82 *Its Runner and Tackles.*
- 83 *The Tackle.*
- 84 *The Fore-Shrouds and Laniards.*
- 85 *The Fore-Stay.*
- 86 *The Fore-Mast Yard and Sail.*
- 87 87 *The Fore-Sheets.*
- 88 88 *The Fore-Tacks.*
- 89 89 *The Fore-Braces.*
- 90 90 *The Fore-Bow-lines.*
- 91 91 *The Bunt-lines.*
- 92 92 *The Leech-lines.*
- 93 *The Fore-Yard Tackle.*
- 94 *The Fore-Geers.*
- 95 *The Puttock-Shrouds.*
- 96 *The Crow-foot.*
- 97 *The Fore-top.*
- 98 *Its Top-Armour.*
- 99 *The Top Rope.*
- 100 100 *The Lifts.*
- 101 *The Cap.*
- 102 *The Fore-top Mast.*
- 103 *The Tackles.*
- 104 *The Fore-top-mast Shrouds.*
- 105 *The Back-Stays.*
- 106 *The Fore-top-sail Halliards.*
- 107 *Stay and Sail.*
- 108 *The Halliards.*
- 109 *The Fore-top-mast Yard and Sail.*
- 110 *The Runner.*
- 111 111 *The Fore-top-sail Lifts.*
- 112 112 *The Fore-top-sail Braces.*
- 113 *The Fore-top-sail Bow-lines.*
- 114 114 *The Fore-top-sail Sheets.*
- 115 *The Fore-top-sail Clew-lines.*



- 116 *The Fore-top-sail Bunt-lines.*
- 117 *The Cross-trees.*
- 118 *The Cap.*
- 119 *The Stump.*
- 120 *The Stay.*
- 121 *The Truck.*
- 122 *The Spindle.*
- 123 *The Vane.*

#### B. Bow-sprit and Rigging.

- 124 *Bow-sprit.*
- 125 *The Horse.*
- 126 *The Sprit-Yard and Sail.*
- 127 *The Sprit-sail Lifts.*
- 128 128 *The Sprit-sail Sheets.*
- 129 129 *Its Clew-lines.*
- 130 130 *The Sprit-sail Braces.*
- 131 *The Bob-stay.*
- 132 *The Top.*
- 133 *The Top Armour.*
- 134 *The Sprit-sail Top-mast.*
- 135 *The Sprit-sail Shrouds.*
- 136 *The Sprit-sail Halliards.*
- 137 *The Crane-line.*
- 138 *The Sprit-top sail Yard and Sail.*
- 139 *The Sprit-sail Top-sail Braces.*
- 140 140 *Its Lifts.*
- 141 141 *Its Sheets.*
- 142 *The Cross-trees.*
- 143 *The Cap.*
- 144 *The Jack-Staff.*
- 145 *The Truck.*
- 146 *The Jack.*
- 147 *The Buoy of the Best Bower-Anchor.*
- 148 *The Cable of the Best Bower-Anchor.*
- 149 *The small Bower-Buoy.*

SHIVERS, so the Seamen call those little round Wheels in which the Rope of a Pulley or Block runs. They turn with the Rope, and have Pieces of Brass in their Centres (which they call the *Cocks*) with Holes in them, into which the Pin of the Block goes, and on which they turn. These *Shivers* are usually of Wood; but some are of Brass, as those in the *Heels* of the *Top-masts*.

SHOALD, is the Miners Term in the Tin-Mines, for such Fragments of Ore, which by Rains, Currents of Water, &c. are torn off from the *Load* or Veins of Ore. These are wash'd down from the Mountains, and by finding of them, they guess where to look for a *Load* of Ore. Sometimes it is called *Squod*, and sometimes *Squad*.

SHOALE, in the *Sea-Phrase*, is the same as Shallow. They say, 'tis good *Shoaling*, when as a Ship sail towards the Shoar she finds, by her Sounding, it grows Shallow by degrees, and not too suddenly; for then a Ship may go in Safety.

SHOARS, Props, or Counterforts, set up to support any thing of Weight, which leans on one side.

SHORT-Accent, in *Grammar*, shews that the Time of Pronunciation ought to be short, and is marked thus (').

SHORT Sails, in a Man of War, are the same with the Fighting-Sails, and are the Fore-sail, Main-sail, and Fore-top-sail: These are all that are used in a Fight, lest the rest should be fired or spoiled; and besides they would be troublesome to handle, and would hinder the Sight and Use of Arms.

When a Ship gives Chase to another, if the Chase hath a mind to fight, they say, the Chase *strips* herself into her *Short* or *Fighting-sails*; that is, puts out her Colours in the Poop, her Flag at the Main-top, and her Streamers, or Pendants, at her Yard-arms; Furls her Sprit-sail, Peeks her Mizzen, and Slings her Main-yard; and when the Chased sees this, he is to prepare for an Engagement.

SHOT of a Cable, is the splicing of two Cables together, that a Ship may ride safe in deep Waters, and in great Roads: For a Ship will ride easier by one Shot of a Cable, than by three short Cables out a-head.

SHOT, for *Ordnance*, are of several Sorts, as *Round-Shot*, which are round Bullets fitted in Proportion to the Bore of the Piece.

*Cross-bar-Shot*, are round Shot, with a long Spike of Iron cast in it, as if it did go through the middle of it.

*Trundle-Shot*, being only a Bolt of Iron 16 or 18 Inches long, sharp-pointed at both Ends, and about a Hand's Breadth from each End, having a round broad Bowl of Lead cast upon it, according to the Bore of the Piece.

*Langrel-Shot*, which runs loose with a Shackle to be shortned when it is put into the Piece; and when it flies out, it spreads itself. At each End of the Bar it has half a Bullet, either of Lead or Iron.

*Chain-Shot*, is two Bullets with a Chain betwixt them, some being contrived round, yet so that they will spread in flying their full Length and Breadth.

*Case-Shot*, is any thing of small Bullets, Nails, old Iron, and the like, to put into the *Case*, to shoot out of *Ordnance*.

SHOULDRING, in *Fortification*, is a Retrenchment opposed to the Enemies, or a Work cast up for a Defence on one side, whether it be made of Heaps of Earth cast up, or of *Gabions* and *Fascines*. A *Shouldring* also is a square *Orillon* sometimes made in the Bastions on the Flank near the Shoulder, to cover the Cannon of a Casemate. Again, it is taken for a Demi-Bastion, or Work consisting of one Face, and one Flank, which ends in a Point at the Head of a *Horn-work*, or *Crown-work*: Neither is it to be understood only of a small Flank added to the sides of the *Horn-work*, to defend them when they are too long, but also of the Redents which are raised on a straight Line.

SHROWDING of *Trees*, in *Husbandry*, is the cutting or lopping off the top Branches of them, which is only practised to Trees that are not fit for Timber, but design'd for Fuel, or some other present Use.

SHROWDS, are great Ropes in a Ship, which come from either Side of all the Masts. They are fastned below by Chains to the Ship's sides, and aloft over the Head of the Mast, their *Pendants*, *Fore-tackle*, and *Swifters* being first put under them: They are also *served* there, to prevent their galling the Mast. The Top-mast Shrouds are fastned to the *Puttocks* by Plates of Iron, and by Dead-mens Eyes and Lanniers also, as the others are. The Terms are *Ease the Shrouds*, that is, slacken them: *Set Taught the Shrouds*; that is, set them stiffer. The Bolt-sprit hath no Shrouds.

SI, in *Musick*, a seventh Note added by one *Le Maire* to the six ancient Notes invented by *Guido Aretin*, as *re*, *mi*, *fa*, *sol*, *la*, *si*, by Means of which



which the Embarrass of the ancient Gamut is avoided. This has been added within this sixty Years; and so ill-natur'd a thing is Jealousy, that for near thirty Years that *Le Meure* was endeavouring to prevail with the Musicians of his Time to embrace this new Note, not a Man would allow of it; but no sooner was he dead than all the World came into it.

**SICUT** *alias*, is a second Writ sent out, when the first was not executed.

**SIDEMEN**, or *Questmen*, be those that are yearly chosen, according to the Custom of every Parish, to assist the Churchwardens in the Enquiry and representing such Offenders to the Ordinary, as are punishable in the *Court Christian*.

**SIDERAL** Year. See *Solar Year*.

**SIDERATIO**. See *Spacelos*.

**SIDES** of *Horn-works*, &c. in *Fortifications*, are the Ramparts and Breast-works which enclose them on the Right and Left from the Gorge to the Head.

**SIEF**, *Album*. See *Collyrium*.

**SIEGE**, is the encamping or sitting down of an Army before a Place, in order to take it either by Force or by Famine.

**SIGHTS**, in *Mathematicks*, are two thin Pieces of Brass rais'd perpendicularly on the two Extremes of an Altitude, or Index of a Theodolite, Circumferentor, or other like Instrument, each of which has an Aperture, or Slit up the Middle, through which the visual Rays pass to the Eye, and distant Objects are seen.

**SIGMOIDES**, are the *Apophyses* of the Bones, representing the Letter C of the ancient *Greeks*. Also the *Valves* of the great Artery that hinder the Blood from returning back to the Heart.

**SIGNALS**, are Signs made at Sea by the Admiral or Commander in Chief of any Squadron of Ships, either in the Day or by Night, either for Sailing or Fighting, or for the better Security of the Merchant Ships that are under the Convoy of his Majesty's Men of War. These Signals are appointed and determined by Order of the Lord High Admiral, and are as follow:

*Signals by Day*, when the Ships are at an Anchor, in weighing Anchor, Sailing, &c. When the Admiral, or Commander in Chief would have the Fleet prepare for sailing, he first looses his *Fore-top-sail*, and then the whole Fleet are to do the same.

2. When he would have them *Unmoor*, he looses his *Main-top-sail*, and fires a Gun; which in the Royal Navy is to be answered by every Flag-Ship.

3. When he would have them *Weigh*, he looses his *Fore-top-sail*, and fires a Gun, and sometimes hauls home his Sheets; the Gun is to be answered by every Flag-Ship, and every Ship to get to sail as soon as it can. If with the Leeward-side, the Stern-most Ship is to weigh first.

4. When the Admiral, or Commander in Chief, would have the Weather-most and Head-most Ships to *Tack* first, he hoists the Union Flag at the *Fore-top-mast-head*, and fires a Gun, which each Flag-Ship must answer.

But if he would have the Stern-most and Leeward-most Ships to *Tack* first, he hoists the Union-Flag at the *Mizzen-top-mast-head*, and fires a Gun. And when he would have all the whole Fleet *Tack*, he hoists an Union both on the *Fore* and *Mizzen-top-mast-head*, and fires a Gun.

5. When, in bad Weather, he would have them *Wear*, and *bring to the other Tack*, he hoists a Pendant on the Ensign-Staff, and fires a Gun: And then the Leeward-most and Stern-most Ships are to *Wear* first, and bring on the other Tack, and lie by, or go on with an easy Sail 'till he comes ahead. Every Flag is to answer with the same Signal.

6. If they are lying by, or sailing by a Wind, and the Admiral would have them *bear up*, and sail before the Wind, he hoists his Ensign, and fires a Gun, which the Flags are to answer; and then the Leeward-most Ships are to bear up first, and to give room for the Weather-most to *Wear*, and sail before the Wind with an easy Sail, 'till the Admiral come ahead.

But if it should happen, when the Admiral hath occasion to *Wear* and sail before the Wind, that both Jack and Ensign be abroad, he will hawl down the Jack before he fires the Gun to *wear*, and keep it down 'till the Fleet is before the Wind.

7. When they are sailing before the Wind, and he would have them *bring to* with the Star-board-Tacks aboard, he hoists a Red Flag at the Flag-Staff on the *Mizzen-top-mast-head*, and fires a Gun; but if they are to bring too with the Lar-board-Tack, he hoists a Blue Flag at the same Place, and fires a Gun. Every Ship to answer the Gun.

8. When any Ship discovers Land, he is to hoist his Jack and Ensign, and keep it aboard 'till the Admiral, or Commander in Chief, answer him by hoisting his; on Sight of which he is to hawl down his Ensign.

9. If any discovers Danger, he is to Tack, or bear up from it; and to aw Jack abroad from the *Main-top-mast-Cross-trees* downward upon the *Back-Stay*, and fire two Guns: But if he should strike or stick fast, then, besides the same Signal with his Jack, he is to keep firing 'till he sees all the Fleet observe him, and endeavour to avoid the Danger.

10. When any sees a Ship, or Ships, more than the Fleet, he is to put abroad his Ensign, and there keep it, 'till the Admiral's or Commander's is out, and then to lower it as often as he sees Ships, and to stand in with them, that so the Admiral may know which Way they are, and how many: But if he be at such a Distance that the Ensign can't well be discovered, he is then to lay his Head towards the Ship, or Ships, so descryed, and to *brail up* his low Sails, and continue hoisting and lowering his *Top-sails*, and making a Weft with his *Top-gallant-sails*, 'till he is perceived by the Admiral.

11. When the Admiral would have the Vice-Admiral, or he that commands in the second Post of the Fleet, to send out Ships to chase, he hoists a Flag, striped White and Red, on the Flag-Staff, at the *Fore-top-mast-head*, and fires a Gun. But if he would have the Rear-Admiral do so, he then hoists the same Signal on the Flag-Staff at the *Mizzen-top-mast-head*, and fires a Gun.

12. When the Admiral would have any Ship to chase to *Windward*, he makes a Signal for speaking with the Captain, and hoists a Red Flag in the Mizzen-throwds, and fires a Gun.

But if to chase to *Leeward*, a Blue Flag; and the same Signal is made by the Flag in whose Division that Ship is. When he would have them



give over Chase, he hoists a White Flag on his Flag-Staff at the Fore-top-mast-head, and fires a Gun: Which Signal is to be made also by that Flag-Ship, which is nearest the Ship that gives Chase, till the Chasing Ship sees the Signal.

13. In case of springing a Leak, or any other Disaster that disables their Ship from keeping Company, you are to hale up your Courses, and fire two Guns.

14. When any Ship would speak with the Admiral, he must spread an *English* Ensign from the Head of his Main or Fore-top-mast downwards on the Shrouds, lowering his Main or Fore-top-sail, and firing Guns till the Admiral observe him: And if any Ship perceives this, and judges that the Admiral doth not, that Ship must make the same Signal, and make the best of his way to acquaint the Admiral therewith, who will answer by firing one Gun.

15. When the Admiral would have the Fleet to prepare to anchor, he hoists an Ensign striped Red, Blue and White on the Ensign-Staff, and fires a Gun, and every Flag-Ship makes the same Signal.

16. If he would have the Fleet *Moor*, he hoists his Mizzen-top-sail with the Clew-lines haled up, and fires a Gun.

17. If he would have the Fleet Cut or Slip, he looses both his Top-sails, and fires two Guns; and then the Leeward Ships are to cut and slip first, to give room to the Weather-most to come to sail.

So if he would have any particular Ship to cut or slip, and to Chase to Windward, he makes the Signal for speaking with that Ship, hoists a Red Flag in the Mizzen-Shrouds, and fires a Gun: But if the Ship is to Chase to Leeward, he hoists a Blue Flag, as before.

18. If he would have the Fleet exercise their *Small Arms*, he hoists a Red Flag on the Ensign-Staff, and fires a Gun; but if the *Great Guns*, then he puts up a Pendant over the Red Flag.

*Signals by Night*, to be observed at an Anchor, in Weighing, Anchoring and Sailing.

1. When the Admiral would have the Fleet to *Unmoor* and *Ride short*, he hangs out three Lights one over another in the Main-top-mast-Shrouds, over the constant Light in the Main-top, and fires two Guns, which are to be answered by the Flag-Ships; and each private Ship hangs out a Light in the Mizzen-Shrouds.

N. B. All Guns fir'd for Signals in the Night, must be fir'd on the same Side, that they may make no Alteration in the Sound.

2. When he would have them *Weigh*, he hangs a Light in the Main-top-mast-Shrouds, and fires a Gun, which is to be answered by all the Flags; and every private Ship must hang out a Light in his Mizzen-Shroud.

3. When he would have them *Tack*, he hoists two Lights on the Ensign-Staff, one over another, above the constant Light in his Poop, and fires a Gun; which is to be answered by all the Flags: And every private Ship is to hang out a Light extraordinary, which is not to be taken in till the Admiral takes in his.

After the Signal is made, the Leeward-most and Stern-most Ships must Tack as fast as they can; and the Stern-most Flag-Ship, after he is about upon the other Tack, is to lead the Fleet, and him

they are to follow, to avoid their running through one another in the Dark.

4. When he is *upon a Wind*, and would have the Fleet *Wear* and *Bring to* on the other Tack, he hoists up one Light at the Mizzen-peak, and fires three Guns; which is to be answered by the Flag-Ships, and every private Ship must answer with one Light at the Mizzen-peak. The Stern-most and Leeward-most Ships are to bear up so soon as the Signal is made.

5. When he would have them, in blowing Weather, to *lie a-try, short*, or *a-bull*, or with the *Head-sails braced to the Mast*, he will shew four Lights of equal Height, and fire five Guns; which are to be answered by the Flag-Ships, and then every private Ship must shew four Lights. And after this, if he would have them to make Sail, he then fires ten Guns; which are to be answered by all the Flags, and then the Head-most and Weather-most Ships are to make Sail first.

6. When the Fleet is Sailing *large*, or before the *Wind*, and the Admiral would have them *bring to*, and *lie by*, with their *Star-board* Tacks aboard, he puts out four Lights in the Fore-Shrouds, and fires six Guns; but if with the *Lar-board* Tacks aboard, he fires eight Guns, which are to be answered by the Flag-Ships, and every private Ship must shew four Lights. The Wind-most Ships must bring too first.

7. Whenever the Admiral alters his Course, he fires one Gun (without altering his Lights) which is to be answered by all the Flag-Ships.

8. If any Ship hath occasion to *lie short*, or *by*, after the Fleet has made Sail, he is to fire one Gun, and shew three Lights in his Mizzen-Shrouds.

9. When any one first discovers Land or Danger, he is to shew as many Lights as he can, to fire one Gun, and to Tack, or bear away from it. And if any one happen to spring a Leak, or any be disabled from keeping Company with the Fleet, he hangs out two Lights of equal Height, and fires Guns till he is relieved by some Ship of the Fleet.

10. If any one discovers a Fleet, he is to fire Guns, make false Fires, put one Light out on the Main-top, three on the Poop, to steer after them, and to continue firing Guns, unless the Admiral call him off, by steering another Course, and fire two or three Guns, for then he must follow the Admiral.

11. When the Admiral anchors he fires two Guns, a small Space of Time one from the other, which are to be answered by the Flag-Ships; and every private Ship must shew two Lights.

12. When the Admiral would have the Fleet to *Moor*, he puts a Light on each Top-mast-head, and fires a Gun; which is to be answered by the Flag-Ships, and every private Ship is to shew one Light.

13. If he would have them *lower* their Yards and Top-masts, he hoists one Light upon his Ensign-Staff, and fires one Gun; which is to be answered by the Flag-Ships, and every private Ship must shew one Light. And when he would have them *hoist* their Yards and Top-mast, he puts out two Lights, one under the other, in the Mizzen-top-mast Shrouds, and fires a Gun; which is to be answered by the Flag-Ships, and each private Ship must shew one Light in the Mizzen-Shrouds.

14. If any strange Ship be discovered coming into the Fleet, the next Ship is to endeavour to speak



Speak with her, and bring her to an Anchor, and not suffer her to pass through the Fleet. And if any one discovers a Fleet, and it blows so hard that he cannot come to give the Admiral Notice timely, he is to hang out a great Number of Lights, and to continue firing Gun after Gun, till the Admiral answers him with one.

15. When the Admiral would have the Fleet to cut or slip, he hangs out four Lights, one at each Main-yard-arm, and at each Fore-yard-arm, and fires two Guns; which are to be answered by the Flag-Ships, and every private Ship is to shew one Light.

#### Signals used when a Fleet sails in a Fog.

1. If the Admiral would have them weigh, he fires ten Guns, which every Flag-Ship is to answer.

2. To make them Tack, he fires four Guns; which are to be answered by the Flag-Ships, and then the Leeward-most Ships, and Stern-most Ships must Tack first. And after they are about, to go with the same Sail they tack'd with, and not lie by, expecting the Admiral to come a-head: And this is to avoid the Danger of running through one another in thick Weather.

3. When the Admiral brings to, and lies with his Head-sails to the Mast; if with the Star-board Tack aboard, he fires six Guns; but if with the Lar-board Tack aboard, eight Guns; which the Flag-Ships are to answer. And after this, if he makes Sail, he fires ten Guns, which the Flag-Ships must answer; and then the Head-most and Weather-most Ships are to make Sail first.

4. If it grow thick and foggy Weather, the Admiral will continue sailing with the same Sail yet that he had before it grew foggy, and will fire a Gun every Hour; which the Flag-Ships must answer, and the private Ships must answer by firing of Muskets, beating of Drums, and ringing of Bells.

But if he be forced to make either more or less Sail than he had when the Fog begun, he will fire a Gun every half Hour, that the Fleet may discern whether they come up with the Admiral, or fall a Stern of him; and the Flags and private Ships are to answer as before.

5. If any one discovers Danger, which he can avoid by Tacking and standing from it, he is to make the Signal for tacking in a Fog; but if he should chance to strike, and stick fast, he is to fire Gun after Gun, till he thinks the rest have avoided the Danger.

6. When the Admiral would have the Fleet to anchor, he fires two Guns, which the Flags are to answer; and after he hath been half an Hour at an Anchor, he will fire two Guns more, to be answered by the Flags, as before, that all the Fleet may know it.

#### Signals for calling Officers on Board the Admiral.

1. When the Admiral puts abroad a Union Flag in the Mizzen-Shrowds, and fires a Gun, all the Captains are to come aboard him: And if with the same Signal there be also a West made with the Ensign, then the Lieutenant of each Ship is to come on Board.

2. If an Ensign be put aboard in the same Place, all the Masters of the Ships of War are to come on Board the Admiral.

3. If a Standard on the Flag-Staff be hoisted at the Mizzen-top-mast-head, and a Gun fired, then all the Flag-Officers are to come on Board the Admiral. If the English Flags only, then a Standard in the Mizzen-Shrowds, and fire a Gun: If the Flags, and Land General-Officers, then the Admiral puts abroad a Standard at the Mizzen-top-mast-head, and a Pendant at the Mizzen-peak, and fires a Gun.

4. If a Red Flag be hoisted in the Mizzen-Shrowds, and a Gun fired, then the Captains of his own Squadron are to come on Board the Admiral; and if with the same Signal there be also a West with the Ensign, a Lieutenant of each Ship must go on Board.

5. If he hoists a White Flag, as before, then the Vice-Admiral, or he that commands in the second Post, and all the Captains of his Squadron are to go on Board the Admiral. If a Blue-Flag, &c. then the Rear-Admiral, and the Captains of his Squadron must come on Board; and if there be a West as before, the Lieutenants.

6. When a Standard is hoisted on the Ensign-Staff, and a Gun fired, the Vice and Rear-Admirals must both come on Board the Admiral's Ship.

7. When the Admiral would speak with Captains of his own Division, he will hoist a Pendant in the Mizzen-peak, and fire a Gun; and if with the Lieutenants, a West is made with the Ensign, and the same Signal: For whenever he would speak with Lieutenants of any particular Ship, he makes the Signal for the Captain, and makes a West also with the Ensign.

8. When the Admiral would have all the Tenders in the Fleet come under his Stern, and speak with them, he hoists a Flag, striped Yellow and White, at the Mizzen-peak, and fires a Gun. But if he would speak with any particular Ship's Tender, he makes a Signal for speaking with the Captain she tends upon, and a West with his Jack.

9. If all the Pinnaces and Barges are to come on Board, manned and armed, the Signal is a Pendant on the Flag-Staff, hoisted on the Fore-top-mast-head, and a Gun; and if he would have them chase any Ship, Vessel or Boat in View, he hoists the Pendant, and fires two Guns.

10. The Signal for the Long-boats to come on Board him mann'd and arm'd, is the Pendant hoisted on the Flag-Staff at the Mizzen-top-mast-head, and a Gun; and if he would have them chase any Ship, Vessel or Boat in open View, without coming on Board him, he hoists the Pendant, as aforesaid, and fires two Guns.

When the Admiral would have all the Boats in the Fleet come on Board him, mann'd and arm'd, he hoists a Pendant on the Flag-Staff, both on the Fore-top-mast, and Mizzen-top-mast-head, and fires one Gun; but if he would have them Chase, he hoists his Pendants, as before, and fires two Guns.

11. When the Admiral would speak with the Victualler, or his Agent, he puts an English Ensign in the Mizzen-top-mast-Shrowds; and when with him that hath Charge of the Gunner's Store, he will spread an Ensign at his Main-top-sail-yard-arm.



*Signals for managing a Sea-Fight.*

When the Admiral would have the Fleet form a Line of Battle, one Ship a-head of another, he hoists an Union-Flag at the Mizzen-peek, and fires a Gun, and every Flag-Ship does the same.

But when they are to form a Line of Battle, one a-breast of another, he hoists a Pendant with the Union-Flag, &c.

2. When he would have the Admiral of the White, or he that commands in the second Post, and his whole Squadron to Tack, and endeavour to gain the Wind of the Enemy, he spreads a white Flag under the Flag at the Main-top-mast-head, and fires a Gun; and when he would have the Vice-Admiral of the Blue do so, he doth the same with a blue Flag.

3. If he would have the Vice-Admiral of the Red do so, he spreads a red Flag from the Cap on the Fore-top-mast-head, downward on the Back-stay: If the Vice-Admiral of the Blue is to do so, he spreads a blue Flag, &c. and fires a Gun. If he would have the Rear-Admiral of the Red do so, he hoists a red Flag at the Flag-Staff at the Mizzen-top-mast-head; if the Rear-Admiral of the White, a white Flag; if the Rear-Admiral of the Blue, a blue Flag, and under it a Pendant of the same Colour, with a Gun.

4. If he be to Leeward of the Fleet, or any Part of it, and he would have them to bear down into his Wake, or Grain, he hoists a blue Flag at the Mizzen-peek, and fires a Gun.

5. If he would be to Leeward of the Enemy, and his Fleet, or any Part of it, be to Leeward of him; in order to bring these Ships into the Line, he bears down with a blue Flag at the Mizzen-peek, under the Union Flag (which is the Signal for Battle) and fires a Gun; and then those Ships which are to Leeward of him, must endeavour to get into his Wake, or Grain, according to their Station in the Line of Battle.

6. When the Fleet is Sailing before the Wind, and he would have him that Commands in the second Post, and the Ships of the Star-board Quarter to clap by the Wind, and come to the Star-board Tack, he hoists a Red Flag on the Mizzen-top-mast-head: but a Blue one, if he would have Ships of the Lar-board Quarter come to the Lar-board Tack, with a Gun.

7. If the Van are to Tack first, he spreads the Union Flag at the Flag-Staff on the Fore-top-mast-head, and fires a Gun, if the Red Flag be not abroad; but if it be, then he lowers the Fore-top-sails a little, and the Union Flag is spread from the Cap of the Fore-top-mast downwards; and every Flag-Ship doth the same.

8. If the Rear be to Tack first, he hoists the Union Flag on the Flag-Staff at the Mizzen-top-mast-head, and fires a Gun, which all the Flag-Ships are to answer.

9. If all the Flag-Ships are to come into his Wake, or Grain, he hoists a Red Flag at his Mizzen-peek, and fires a Gun, and all the Flag-Ships must do the same.

10. If he would have him that Commands in the second Post of his Squadron to make more Sail (though he himself shortens Sail) he hoists a White Flag on the Ensign-Staff: But if he that Commands in the third Post be to do so, he hoists a Blue Flag at the same Place, and fires a Gun, and all the Flag-Ships must make the same Signal.

11. Whenever he hoists a Red Flag on the Flag-Staff at the Fore-top-mast-head, and fires a Gun, every Ship in the Fleet must use their utmost Endeavour to engage the Enemy, in the Order prescribed them.

12. When he hoists a White Flag at his Mizzen-peek, and fires a Gun, then all the small Frigats of his Squadron, that are not of the Line of Battle, are to come under the Stern.

13. If the Fleet be sailing by a Wind in the Line of Battle, and the Admiral would have them brace their Head-sails to the Mast, he hoists up a Yellow Flag on the Flag-Staff at the Mizzen-top-mast-head, and fires a Gun, which the Flag-Ships are to answer, and then the Ships in the Rear must brace first.

14. After this, if he would have them fall their Head-sails, and stand on, he hoists a Yellow Flag on the Flag-Staff at the Fore-top-mast-head, and fires a Gun, which the Flag-Ships must answer; and then the Ships in the Van must fall first, and stand on. If when this Signal is made, the Red Flag at the Fore-top-mast-head be abroad, he spreads the Yellow Flag under the Red.

15. If the Fleets being near one another, the Admiral would have all the Ships to Tack together, the sooner to lie in a Posture of engaging the Enemy, he hoists a Union Flag on the Flag-Staves at the Fore and Mizzen-top-mast-heads, and fires a Gun, and all the Flag-Ships in the Fleet are to do the same.

16. The Fleet being in a Line of Battle, if he would have the Ship that leads the Van, hoist, lower, set, or hawl up any of her Sails, the Admiral spreads a Yellow Flag under that at his Main-top-mast-head, and fires a Gun; which Signal the Flag-Ships are to answer, and then the Admiral will hoist, lower, set, or hawl up the Sail which he would have the Ship that leads the Van do; which is to be answered by the Flag-Ships of the Fleet.

17. When the Enemy runs, and he would have the whole Fleet follow them, he makes all the Sail he can after them himself, takes down the Signal for the Line of Battle, and fires two Guns out of his Fore-Chace, which the Flag-Ships answer, and then every Ship is to endeavour to come up with, and board the Enemy.

18. When he would have the Chase given over, he hoists a White Flag at the Fore-top-mast-head, and fires a Gun.

19. If he would have the Red Squadron draw into a Line of Battle, *one a-breast* of another, he puts abroad a Flag, striped Red and White, on the Flag-Staff at the Main-top-mast-head, with a Pendant under it, and fires a Gun: If the White, or second Squadron are to do so, the Flag is striped Red, White and Blue; if the Blue, or third Squadron, is to do so, the Flag is a *Genouese* Ensign and Pendant: But if they are to draw into a Line of Battle, *one a-head of another*, the same Signals are made without a Pendant.

20. If they are to draw into a Line of Battle, *one a-stern* of another, with a large Wind, and he would have the Leaders go with the Star-board Tacks aboard by the Wind, he hoists a Red and White Flag at the Mizzen-peek, and fires a Gun: But if they should go with the Lar-board Tacks aboard by the Wind, he hoists a *Genouese* Flag at the same Place; which Signals must be, like others, answered by the Flag-Ships.



**SIGNET**, is one of the King's Seals, where-with his private Letters are sealed, and is always in the Custody of the King's Secretaries; and there are four Clerks of the Signet-Office always attending.

**SIGNIFICABIT**, is a Writ *de Excommunicato capiendo*, which issueth out of the *Chancery* upon a Certificate given by the Ordinary, of a Man that stands obstinately Excommunicate by the Space of forty Days, for the laying him up in Prison without Bail or Mainprise, until he submit himself to the Authority of the Church. And 'tis so called, because the Word *Significavit* is an Emphatical Word in the Writ. There is also another Writ in the *Register*, *Fol. 7.* directed to the Justices of the Bench, commanding them to stay any Suit depending between such and such, by reason of an Excommunication alledged against the Plaintiff; because the Sentence of the Ordinary that did excommunicate him, is appealed from, and the Appeal yet depends undecided.

**SILQUA**, in *Botany*, is the Seed-Vessel, *Husk*, *Cod*, or *Pod*, of such Plants as are of the Leguminous kind.

**SILLON**, in *Fortification*, is an Elevation of Earth, made in the middle of a Moat, to fortify it when too broad: It is otherwise called *Envelope*, which is the more common Name.

**SILVER**, by *Chymists*, is called *Luna*, i. e. the Moon; and several Preparations are made from it, particularly a Tincture of Silver, by dissolving thin Silver Plates, or Silver shot in Spirit of Nitre, and pouring the Dissolution in another Vessel full of Salt-water.

**SILVER**, of the ways of Smelting and Refining of Silver, I find these Accounts. 1. From Mr. Ray, at the End of his Catalogue of *English Words* about the Silver Mines in *Cardiganshire* in *Wales*.

The Mine, first beaten into small Pieces, is brought from the Mine to the Smelting-House, and there melted with *black and white Coal*, i. e. with Charcoal and Wood slit into small Pieces, and dried in a Kiln for that Purpose: And they use both Wood and Coal, because Coal alone makes too violent a Fire, and the Wood alone too gentle. After the Fire is made, the Mine is cast on the Coals, and so again, Mine and Coals interchangeably. The Mine, when melted, runs down into the *Sump*, which is a round Pit of Stone lined with Clay within; then 'tis laden out, and cast into square Bars with smaller Ends, fit to lift and carry them by.

These Bars they bring to the Refining Furnace, which is covered with a thick Cap of Stone bound about with Iron, and moveable, that so they may lift it up, and make the *Test* at the Bottom a-new (as they do at every Refining). In the Middle of the Cap there is a Hole, in which the Bar of Silver hangs in Iron Slings above the Furnace, that so it may be let down by Degrees as it melts off. Besides this Hole, they have another in the Side of the Furnace, parallel to the Horizon, and bottom'd with Iron; at which Hole they thrust in another Bar. The *Test* is of an oval Figure, and fits at the Bottom of the Furnace. The Fire is put in by the Side of the Bellows. When the Furnace is come to a true Temper of Heat, the Lead, converted into Litharge, is blown off by the Bellows, the Silver subsiding to the Bottom of the *Test*.

V O L. II.

As soon as all the *Glut* (as they call it) of Litharge is blown off, the Silver in the Bottom of the *Cuple*, or *Test*, grows cold, and the same Degrees of Heat will not keep it melted as before. The Cake of Silver, after it grows cold, *springs or rises up into Branches* (saith Mr. Ray, but I question his Information as to this Point.) The *Test* is made of Marrow-Bones, burnt to small Pieces, then powder'd and made into a Paste with Water. The *Test* is about a Foot thick, laid in Iron. After the Cake of Silver is taken out, that Part of the *Test* which is discoloured, they mingle with new Ore to be melted; the rest they pound and powder, and use again for another *Test*.

The Litharge is brought to a Reducing Furnace, and there with Charcoal only melted into Lead. The Litharge is cast upon the Charcoal in the *Bing* of the Furnace; and as the Charcoal burns away, and the Litharge melts, more Charcoal is thrown on, and Litharge put upon it, as at first Smelting.

Another Furnace they have, which they call an *Almond Furnace*, in which they melt the *Slugs* (or Refuse of the Litharge) not stamped or pound-ed with Charcoal only.

The Slugs or Cynders of the first Smelting, they beat small with great *Stamps*, lifted up by a Wheel moved by Water, and falling down by their own Weight. First, they are stamped with dry Stamps, then sifted with an Iron Sieve in Water. That which lies at the Bottom of the Sieve is returned to the Smelting Furnace, without more ado; that which swims over the Sieve is beaten with wet Stamps.

What hath pass'd through the Sieve, and also what after being beaten with the wet Stamps, passes through a fine Grate, or Strainer of Iron, goeth to the *Buddle*; which is a Vessel made like a shallow Tumbrel, and stands a little Shelving.

On this the Matter is laid, and Water runs constantly over it, the Matter being moved to and fro with an Iron Rake; by which Means the Earth and Dross being carried off by the Water, the Metal remains behind.

That which is thus *Buddled*, they lue with a thick Hair Sieve, close wrought in a Tub of Water, rolling the Sieve about, and inclining it this way and that with their Hands. The light Part which swims at Top of the Sieve, or rather over it, is returned again to the *Buddle*; and that which subsides, goes to the Furnace to be Smelted again.

They have also an *Affay Furnace*, wherewith they try the Value of the Metal, of what Proportion the Lead bears to the Silver; which they do by cutting off a Piece from every Bar, and melting it in a small Cupel: First, they weigh the Piece cut off, and then, after the Lead is separated, the Silver. A Tun of Metal sometimes will yield ten, fifteen, and, if rich, twenty Pound weight of Silver.

All Lead Ore, digg'd in *England*, hath a Proportion of Silver mix'd with it; but some so little, that it will not quit cost to refine it.

At the first Smelting they mingle several Sorts of Ore together, some richer, some poorer, else they will not melt so kindly. The Silver made here is exceeding good and fine. These six Mountains in *Cardiganshire*, not far from one another,

6 O

afford



afford Silver Ore; *Talabout*, *Geginnon*, *Comfom-lack*, *Gedarren*, *Bromesloid*, and *Cummer*. But when Mr. Ray was there, they digg'd only at *Talabout*.

Their way of Digging and Collecting the Ore was thus: They sink a perpendicular square Hole, or *Shaft*, the Sides of which they strengthen round from Top to Bottom with Wood, that the Earth may not fall in. The Transverse Pieces of Wood they call *Stemples*; and on these, catching hold with their Hands and Feet, they descend without using any Rope. They dig the Ore thus; one holds a little Pique, or Punch of Iron, having a long Handle of Wood, which they call a *Gad*, and another with a great Iron Sledge drives it into the Vein.

The Vein of Metal runs *East* and *West*; it rises *North*, and dips or slopes to the *South*. There is a white *Fluor* about the Vein, which they call *Spar*, and a black one, which they call *Blinds*: This last covers the Vein of Ore; so that when it appears, they are sure to find Ore.

There are several Silver Mines at *Schemnitz* in *Hungary*, the chiefest of which are *Windschaht* and *Trinity*: Of which Dr. Edward Brown gives us this Account in *Philosophical Transactions*, N<sup>o</sup> 58, *Trinity* Mines are seventy Fathom deep, built and kept open with Under-work at a great Expence. Much of this Mine being in an earthy Soil, its Ore is much esteemed. Diverse Veins lie *North*, and others run to the *North-East*. The blackish Ore is esteemed the best; much of it hath a Mixture of a yellow shining Substance, called *Marchasite*; which if not in too great Quantity, disposes the Ore to Fluidity, and makes it melt and run the better. There is often found growing to the Ore a red Substance, called *Cinnabar*; this Substance, ground with Oil, makes a Vermillion equal to, if not exceeding that *Cinnabar* which is made by Sublimation of Mercury and Sulphur.

An hundred Pound of Weight of Ore sometimes yields but half an Ounce, or an Ounce of Silver; sometimes two, three, four, five, and twenty Ounces.

There is an Officer in the Works, whom they call the *Probeirer*, or *Essayer*, who proves the Richness of the Ore, thus: Of all sorts of Ore he takes the same Quantity, and having first dried, burned, and powder'd them, then he gives an equal Proportion of Lead to all, melteth and purifieth them; and then by exact Scales he takes notice of the Proportion between the Ore and the Metal contained in it, and reports it to those concerned in the great Melting-Furnaces.

If the Ore be found to hold two Ounces and a half, or more, of Silver, in an hundred Pound Weight, they ordinarily melt it, without any previous Preparation by the Help of *Iron-Stone* (which, by the by, is not Iron-Ore, but a Stone found thereabouts, of which the Liver-colour is the best.) *Kys* (which is a sort of *Pyrites*) and *Slacken* (a Scum or Lake taken off the Top of the Pan, into which the melted Mineral runs, and is a Substance made out of the former, melted by Fusion) which are thrown with it into the Melting-Furnace.

If the Ore be poorer, holding but two Ounces in an hundred Pound Weight, or less; then 'tis first pounded and wash'd, 'till it becomes richer, or hath a greater Proportion of Metal, with respect to the Ore, much of the earthy Parts being washed

away. Then 'tis thrown into the Furnace with the former Materials; and the *Marchasite*, which remains still with it, as sinking always to the Bottom with the Silver in the *Wash-works*, helps to quicken the Fusion of the Ore.

Whatever is melted in the Melting-Furnace, is let out through a Hole at the Bottom thereof into the Pan, which is placed in the Earth before it. And thus exposed; it immediately acquires an hard Scum, Dross, Loaf, or Cake; which being taken off from the Top, the Metal remaining becomes the purer; to which is added *Lead*, and after some time the melted Metal is taken out. Then being again melted in the *Driving Furnace* (as they call it) the Lead, or what else remains mix'd with the Silver, is driven off by the Blast of two great Bellows, and runs over in the Form of *Litharge*. That which first comes over is the *White*, and that which is last, being longer in the Fire, is *Red*; the former is called *Litharge* of Silver, the last of Gold; but are both blown off the same Metal.

Most of this *Schemnitz* Silver-Ore holds some Gold, which is separated from the Silver by Granulation and Dissolution in *Aqua Fortis*.

When Silver is generated (as 'tis in some Places of *America*, and perhaps elsewhere) in rocky Stones, abounding with Bituminous Mixtures, so as that it can't be forced from its Impurities by the violent way of Melting, though *Lead*, and even artificial Salts, or Fluxes, be added: In this Case the Use of Quicksilver hath been found most advantageous. The way of applying it is thus:

They calcine the Ore, first broken into small Pieces, in a Reverberatory Oven, but with a moderate Fire, for fear of Fusion, and driving away into the Air part of the Metal. This Calcination frees the Mineral from such Mixtures as would hinder the Power of the Quicksilver upon it, and also renders the Ore more tractable and pliant under the Millstone; where 'tis reduced to a fine Powder, before the Application of the Mercury upon it. For the Ore being ground, calcined, powder'd, and finely sifted, they divide it into several Heaps, and then by lesser Essays they find how much Silver is contained in each Heap; where 'tis very ordinary to find not above six Ounces in an hundred Pound Weight, sometimes twelve; but if it arises to eighteen, 'tis esteemed a very rich Vein: Yet sometimes there are great Masses found of pure Silver, which they call *Virgin-Metal*.

Then proportionable to the Quantity of Silver in each Heap, they besprinkle them with Quicksilver, and that not all at once, but at several times, stirring the Ore up and down. If the Mercury give Signs of its being *Tocado* (as they call it) *i. e.* if it appear *mortified*, not in small and clear spherical Figures (which is a good Prognostick) but in the Form of long Worms, of a wan, pale, dark, and leadish Colour (which indicate that the Ore abounds with *Lead*, &c.) it is cured by certain Magistral, which have for their Basis, or master Ingredient, calcined Copper mingled with Salt.

The Heaps of Ore being thus mingled with Quicksilver, are often stirred about, the better to incorporate the Mercury and Silver. They seem to have only conjectural Signs to know when the Quicksilver hath done its Office, in separating the Silver from these Heterogeneous Substances; which occasions by its uncertainty great Losses, especially



especially when they work this way in Gold. But when by the Colour of the Mercury, coagulated by the Silver in clear massy Lumps, they conjecture the Work done, they wash it by Means of *three Vessels*, standing in order, one under another: So that the Matter in the first and highest, being work'd and stirr'd about with a *Molinet*, all the Dust of the Heterogeneous Matter that imbody not with the Mercury, is carried away, together with the Water, into other Vessels, and from thence is quite thrown out by the continual Current of the Water; while the Silver in clotted Lumps (called *Pella's*) is, by the Weight of the Mercury, carried down to the Bottom of the Tubs. Then the Mercury, with the Silver, is taken out of the Vessels, and diligently squeezed in strong coarse Linnen-cloths, and even with Strokes of a Beetle, that the Quicksilver may be separated as much as may be from the Silver. And this Mass is afterwards reduced in Molds of the Shape of the *Indian Pine-apple*, into a Pyramidal or Conical Figure, which they call *Pineas de la Plata*: They are thus fashioned for the easier placing them round the Edges of a great earthen Vessel, of the Form of a blind Alembick: Round about the Top of which a Fire is made, and then all the rest of the Mercury forthwith abandons the Silver, and falls to the Bottom; from whence its recovered and kept for the like Use again.

The Silver last of all is melted down with *Liga*, as 'tis called, which the King of *Spain* allows, by which he returns to the People in Copper the fifth Part, which they allow him of all the Silver. *Philosoph. Transf.* N<sup>o</sup> 41.

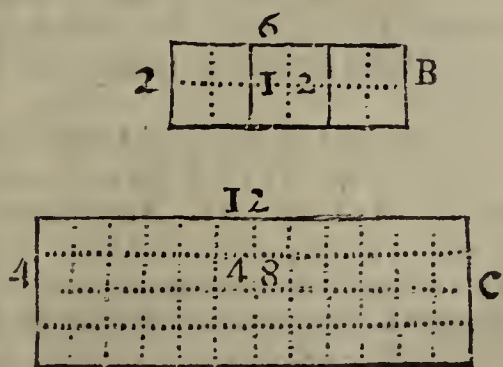
**SIMATIUM**,  $\left\{ \begin{array}{l} \text{in Architecture, is the upper-} \\ \text{SIMAISE,} \end{array} \right. \left\{ \begin{array}{l} \text{most and last Member of the} \\ \text{grand Cornices, called the great Doucine, or Gula} \\ \text{recta. In the Antique Buildings the Simiatum at} \\ \text{Top of the Dorick Cornice, is generally in Form} \\ \text{of a Cavetto, or Semi Scotia. But in the Ionick,} \\ \text{the Simatium is always a Doucine.} \end{array} \right.$

**SIMILAR Arks** of a Circle, are such as are like Parts of their whole Circumference.

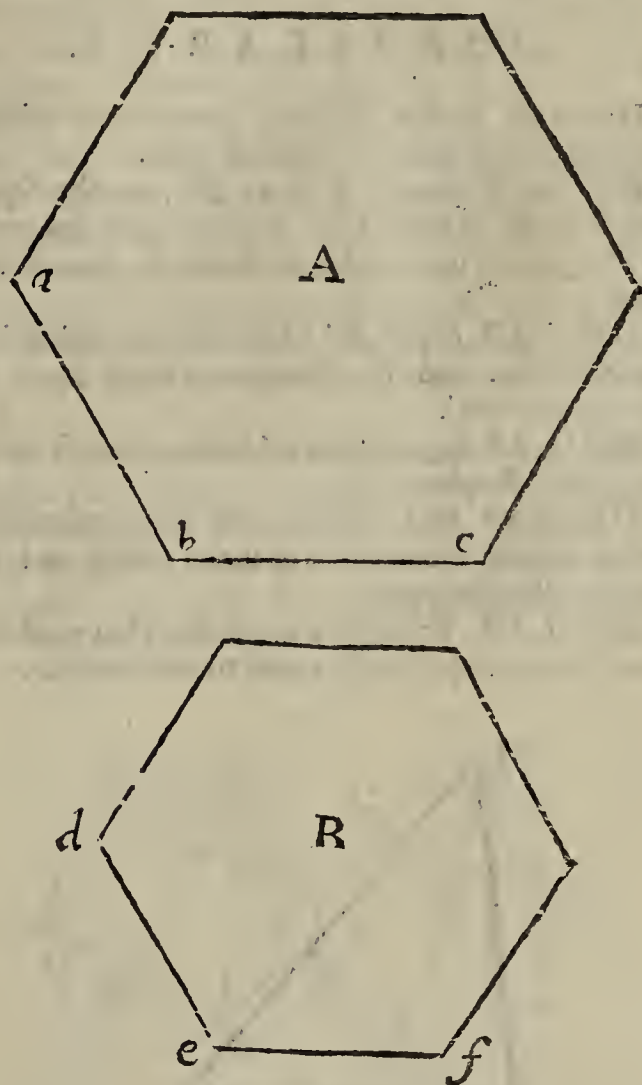
**SIMILAR Bodies**, in Natural Philosophy, are called such as have their Particles of the same Kind and Nature one with another.

**SIMILAR**, or *simple Parts*, by Anatomists are called such as are throughout of the same Nature and Texture, as all the Parts of the Bone are bony, &c.

**SIMILAR Plane Numbers**, are those Numbers which may be ranged into the Form of *similar Rectangles*; that is, into Rectangles, whose Sides are Proportional, such are 12 and 48; for the Sides of 12 are 6 and 2 (as in Fig. B.) and the Sides of 48 are 12 and 4 (as in Fig. C.) But  $6:2::12:4$ , and therefore those Numbers are *similar*.

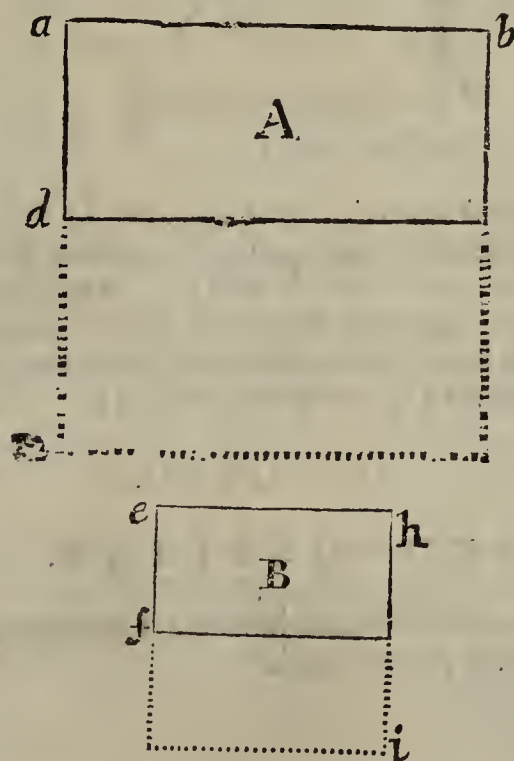


**SIMILAR Polygons**, are such as have their Angles severally equal, and the Sides about those Angles proportional.



Thus, if in the Polygon A, all the Angles  $a b c$ , &c. are respectively equal to all those  $d e f$ , &c. in the Polygon B. And that also  $a b$  hath the same Proportion to  $b c::$  as  $d e$  hath to  $e f$ . Then those two Polygons are *similar*.

**SIMILAR Rectangles**, are those which have their Sides about the equal Angles proportional; that is, as  $a b: e h:: a d: e f$ .



#### COROLLARY I.

All Squares must be *similar Rectangles*; for (since they have all their Sides equal, and all their Angles right)



right) whatever Proportion the Side  $a m$  hath to the Side  $b i$  of the other *Rectangle*, the same must also the other Side  $a b$  have to the Side  $e b$ ; because they are equal to  $a m$ , and to  $b i$ .

## C O R O L L A R Y II.

Hence all *similar Rectangles* are to each other as the *Squares* of their *Homologous Sides*.

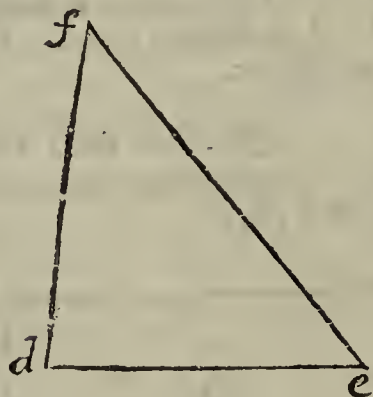
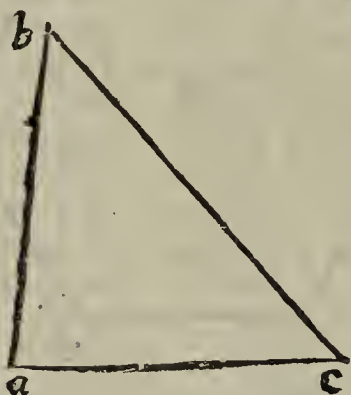
For the *Rectangle* A is to B :: as the Square  $b m$  is to the Square  $e i$ ; since as well *Squares* as *Rectangles* are in a duplicate Ratio to that of their Sides.

*SIMILAR Right-lin'd Figures*, are such as have equal Angles, and the Sides about those equal Angles proportional.

*SIMILAR Segments* of a Circle, are such as contain equal Angles.

*SIMILAR solid Numbers*, are those, whose little Cubes may be so ranged as to make *similar* and *rectangular Parallelopipeds*.

*SIMILAR Triangles*, are such as have all their three Angles respectively equal to one another.



As if the Angle  $a$  be equal to  $d$ , the Angle  $c$  equal to  $e$ , and the Angle  $b$  equal to  $f$ ; then is the Triangle  $a b c$  *similar* or *like* to  $d f e$ : And then the Sides about the equal Angles are always proportional; that is,  $a b$  hath the same Proportion to  $a c$ , as  $f d$  hath to  $d e$ , and is thus written;

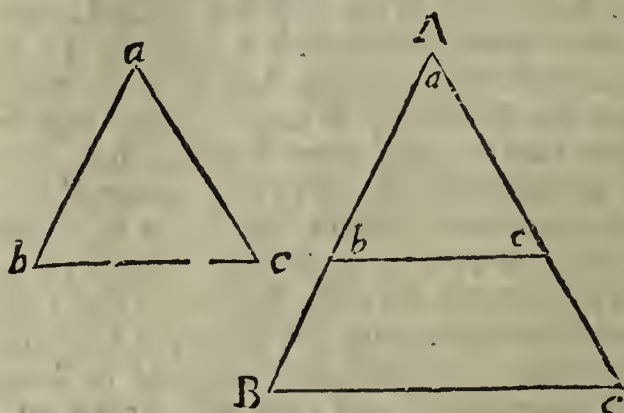
$$a b : a c :: f d : d e.$$

## P R O P O S I T I O N.

All *Similar Triangles* have the Sides about their equal Angles proportional.

Thus in the Figure.

I say,  $A B : a b :: A C : a c :: C B : b c$ , &c.



For set the lesser Triangle into the greater, by taking  $A b = a b$ , and  $A c = a c$ , then will the Base  $b c$ , be the same as in the lesser Triangle; and the whole Triangle  $A b c$ , will be equal to  $a b c$ .

And therefore the Angle  $A b c$ , will be equal to the Angle B, and  $A c b = C$ .

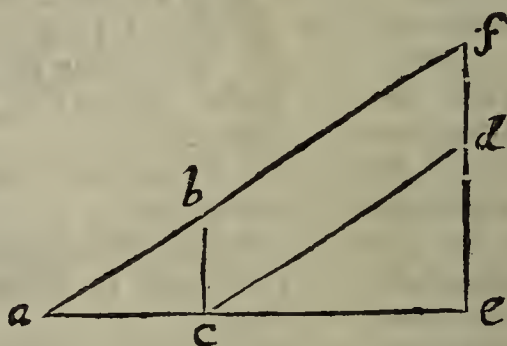
Wherefore the Line  $b c$ , is parallel to  $B b$ : And therefore,

$$A b : A B : A c : A C :: b c : B C, \text{ \&c.}$$

Q. E. D.

Otherwise thus, according to *Euclid*;

Let the Triangle  $a b c$ , be *similar* to  $d c e$ . Then I say, That the Sides about their equal Angles are Proportional.



Set the Bases of the two Triangles  $a c$  and  $e c$ , so together, as that they may join and make one Right Line  $a e$ ; and draw out the Lines  $a b$  and  $e d$ , 'till they meet together in the Point  $f$ .

## D E M O N S T R A T I O N.

Because the Angle  $a =$  Angle  $d c e$ ,  $a f$ , is parallel to  $c d$  also, because the Angle  $a c b$  is equal to the Angle  $c e f$ , the Lines  $b c$  and  $f e$  are parallel. Wherefore  $b c d f$ , must be a *Parallelogram*, whose opposite Sides are equal, that  $b f = c d$ , and  $b c = f d$ .

Therefore because  $c d$  is parallel to the Base  $a f$  of the Triangle  $f e a$ ,  $d e : f d$  (or  $b c$ ) ::  $e c : a c$ .

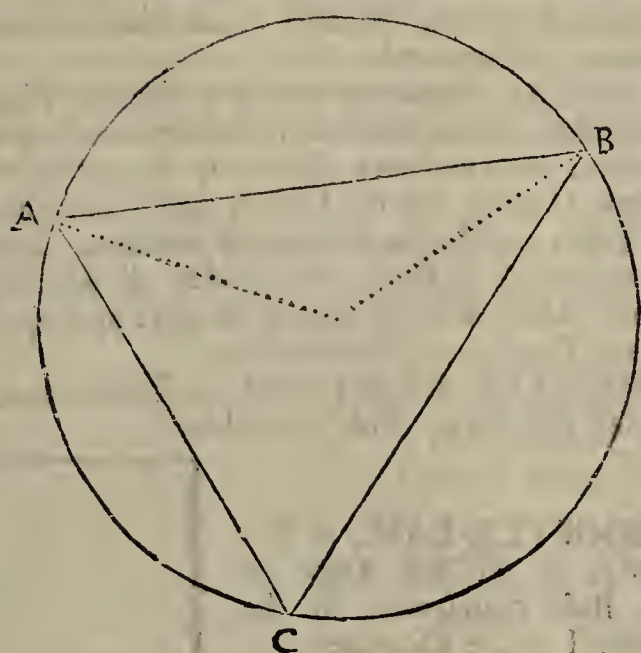
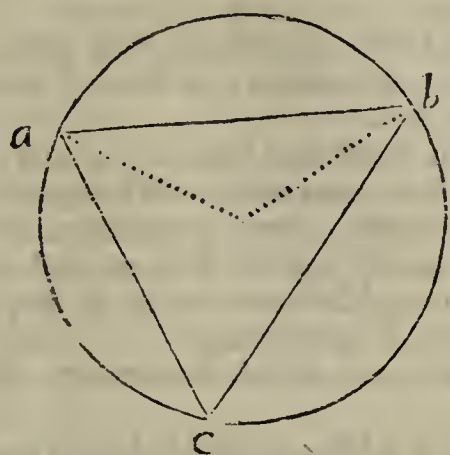
That is,  $d e : b c :: e c : a c$ . And therefore alternately,  $d e : c e :: b c : a c$ . And so the Sides about  $c$  and  $e$  are proved proportionable.

Also, because  $b c$  is parallel to the Base  $f e$  of the Triangle  $a f e$ ; Therefore  $e c : a c :: f b$ , (or  $c d$ ) :  $a b$ : That is,  $e c : a c :: c d : a b$ . And therefore alternately,  $e c : c d :: a c : a b$ . And so the Sides about the equal Angles  $a$ , and  $d c e$ , are found proportional.



portional. The same may be easily done by the Angles  $b$  and  $d$ .

Another Demonstration by Pardie.



Because the Angle  $A$  is  $=$  to  $a$ , Angle  $C$  to  $c$ , &c. Therefore the Ark opposite to them must be equal: (That is, not in Length, but must contain an equal Number of Degrees.) Wherefore Chords also subtending those Arks, must be proportionable Chords of the same Number of Degrees; and consequently will be all similar Parts of their own proper Radius.

That is,  $ca : ab ::$  (in respect of its Radius)  $CA : AB$ , in respect of its Radius. Therefore the Sides about the equal Angles will be proportional.

Or,  $bc : ba :: BC : BA$ . Q. E. D.

### C O R O L L A R Y I.

From hence it follows, That all *similar Triangles* are to one another as the Squares of their Homologous Sides. For these *Triangles* are the Halves of *similar Triangles*, or *Parallelograms*, which are to one another in a *Duplicate Ratio* of their Homologous Sides: Therefore the Halves must be as the Wholes.

### C O R O L L A R Y II.

All *Similar Polygons* are to one another as the Squares of their Homologous Sides. For being made up of *similar Triangles*; the Aggregates, or Sums, will be to each other, as the Parts out of which they were made.

**SIMILAR**, in *Arithmetick and Geometry*. Those things are said to be *similar* and alike, which can-

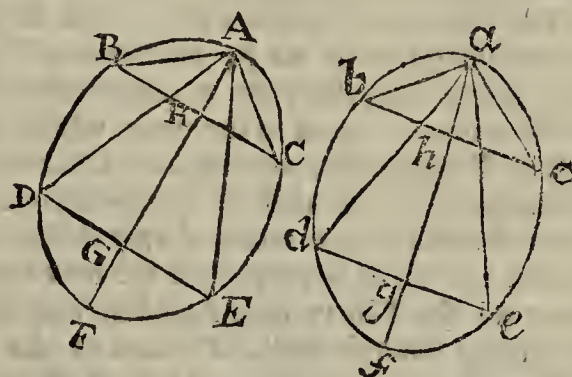
not be distinguish'd but by their Comprehension, *i. e.* by immediately applying the one to the other, or some other third to them both.

**SIMILAR Disease**, in *Physick*, is a Disease of some simple, solid Part of the Body; as of a Fibre with regard to its Tension or Flaccidness, of a Membrane, a Nervous Canal, &c.

**SIMILAR Parts**, in *Anatomy*, are those Parts of the Body that at the first Sight appear to consist of like Parts, or Parts of the same Nature, as the Bones, Cartilages, Ligaments, Membranes, Arteries, Fibres, Nerves, Skin, Flesh, Veins.

**SIMILAR Light**, according to Sir *Isaac Newton*, is such, whose Rays are all equally refrangible; and this he calls also Simple and Homogeneous.

**SIMILAR Sections**, in *Conicks*, are such whose Diameters make equal Angles with their Ordinates; and also where the Triangles  $ADE$ ,  $ABC$ , are Similar to the Triangle  $ade$ ,  $abc$ , and the Bases  $DE$  to  $BC$ ; as  $de$  to  $bc$ . Their Diameters also as  $AF$  and  $af$ , are called Similar.



**SIMILITUDE**, in *Arithmetick, Geometry, &c.* The Relation of two things similar to each other, or which are only distinguishable by Comprehension.

**SIMONY**, is an unlawful Contract made to have a Man presented to a Rectory, or Vicarage: It was agreed by all the Justices, that if the Patron present any Person to a Benefice with Cure, for Money, that such Presentation, &c. is void, tho' the Presentee were not privy to it, and the Statute gives Presentation to the King: But this is now repealed.

**SIMPLE Flank**. See *Flank*.

**SIMPLE Place**, a Term in *Geometry*. See *Place Simple*.

**SIMPLE Problem**. See *Linear Problem*.

**SIMPLE Problem**, in *Mathematicks*. See a *Linear One*.

**SIMPLE Quantities**, in *Algebra*, are such as have but one Sign, whether Positive or Negative: Thus,

$2a$ , and  $-3b$ , are *Simple Quantities*.

But  $a + b$ , and  $+d - c + b$ , are *Compound ones*.

**SIMPLE Equation**, in *Algebra*, is an Equation where the unknown Quantity is but of one Dimension, as *e. gr.* of  $x = (a + b) : 2$ .

**SIMPLE**, in *Botany*, is a Name given in general to all Herbs and Plants, as having each its particular Vertue, whereby it becomes a simple Remedy.

**SIMPLE Light**. See *Homogeneous*.

**SIMPLE Tenaille**. See *Tenaille*.

**SINAPISM**, in *Pharmacy*, an external Medicine in the Form of a Cataplasm; composed principally of Mustard-Seed powder'd and mix'd up



with the Pulp of Figs, or some other Simple of a hot Quality.

**SINCERITY**, in *Ethicks*, is defined to be that *Virtue, Power, or Act* of the Mind, by which the Will is determined to follow and perform that which the Intellect determines to be best and most proper to be done in all Cases, and to do it because it is so.

**SINCIPUT**, the fore Part of the Head, reaching from the Fore-head to the *Coronal Suture*.

**SINE**, or *Right Sine*, is a right Line drawn from one End of an Arch perpendicularly upon the Diameter drawn from the other End of that Arch; or it is half the Chord of twice the the Arch. See more under the Word *Trigonometry*.

**SINE assensu capitali**, is a Writ against him that alienates Lands without Consent of his Chapter or Covent.

**SINE-CURES**, are Ecclesiastical Benefices without Cure of Souls. No Church where there is but one Incumbent, can properly be a *Sine-cure*: And though the Church being down, or the Parish being become destitute of Parishioners, the Incumbent may thereby be necessarily acquitted from the actual Performance of publick Duty, yet he is still under an Obligation to do it, whenever a Church shall be built, and there are a competent Number of Inhabitants. And in the mean while, if the Church be *Presentative*, as most such Churches are, the Incumbent is instituted in *Curam Animarum*; and such Benefices are rather *Depopulations* than *Sine-cures*, and 'twill be proper for the new Incumbent to read the Thirty-nine Articles, and the Liturgy, in the Church-yard, &c. and to do what other Incumbents usually do. But a *Rectory*, or a *Portion* of it, may properly be a *Sine-cure*, if there be a Vicar endowed, and then it doth not come within the Statute of *Pluralities* of 21 Hen. 8. c. 13. which declares, that no Parsonage which hath a Vicar endowed, shall be comprehended, &c. So that here no Dispensation is necessary to hold this *Sine-cure* with a former Living. Nor need he read the Articles or Divine Service, as required by 13 Eliz. c. 12. which extends only to a *Benefice with Cure*. A *Sine-cure* Donative wants no Institution and Induction. But one *Presentative* must have both; especially if it consist in *Glebe* and *Tithes*, and not in a *Portion* of Money. But the Institution must not run in *Curam Animarum*, but in *Recloriam sive Portionem Recloriæ de A. B. &c.* By the above-mentioned Stat. 21 Hen. 8. not only Prebends and Rectories, with Vicarages endowed, but Deanries and Archdeaconries are declared to be Benefices without Cure.

**SINE Complement.** See *Complement*.

**SINE die**, in Law, when Judgment is given against the Plaintiff, he is said to be in *miseriordia pro falso clamore suo*: But when for the Defendant, then 'tis said, *Eat inde sine die*.

**SINES** on the *Plain Scale*, *Gunter's Scale*, and almost all *Scales* have a *Line*, called the *Line of Sines*. This on the *Sector* is double, one on each Leg, and hath there many excellent Uses; some of which are these:

1. *The Radius of a Circle being known, to find the Sine of any Arch or Angle.*

Fit in the Radius between 90 and 90 in the Lines of Sines, and the parallel Distance between the Numbers of Degrees, answering to any Works or Angles, will give their *Sines*. Thus the Parallel Distance between 60, 30, 45, &c. will give the

*Sines* of 60°, 30°, 45°, &c. And, *vice versa*, from the Sine given you may find the Radius, by fitting the Sine into the *Sector* parallel-wise between the Numbers expressing its Degrees: For then the Parallel Distance between 90 and 90, will be the Radius sought.

2. *The Radius of a Circle being given, and any Right Line less than it, to know of what Ark it may be the Sine.*

Apply in the Radius between 90 and 90, in the Lines of Sines, and taking the Length of the Line in the Compasses, carry it parallel to the Radius, 'till it fall exactly on like Sines on each Side; and the Degrees and Minutes where it fits, shall give you the Sine it represents.

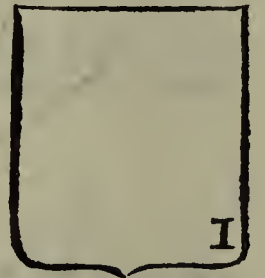
**SINGLE**, or *Simple Excentricity*. See *Eccentricity*.

**SINGULTUS**, or the *Hickough*, is a Convulsive Motion of the Midriff, caused by tough and irregular Particles, forcing it to this disordinate Motion. *Blanchard*.

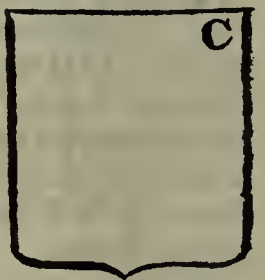
**SINICAL Quadrant** is made of Brass or Wood, with Sines drawn from each Side, intersecting one another, with an Index divided by Sines also, with ninety Degrees on the Limbs, and two Sights to the Edge, to take the Altitude of the Sun. Sometimes instead of Sines, 'tis divided all into equal Parts: And is used by Seamen to solve by Inspection any Problem of *Plain-Sailing*.

**SINISTER** Side or Part of an Escutcheon, is the left Side Part. *Vide Escutcheon*:

**SINISTER-BASE**, in *Heraldry*, is the left Angle of the Base represented by the Letter I in the Escutcheon.



**SINISTER-CHIEF**, in *Heraldry*, is the left Angle of the Chief represented by the Letter C in the Escutcheon.



**SINISTER Aspect**, in *Astronomy*, an Appearance of two Planets happening according to the Succession of the Signs, as *Saturn* in *Aries*, and *Mars* in the same Degree.

**SINNET**, is a Line or String made of Rope-yarn, consisting generally of two, six or nine Strings, which are divided into three Parts, and are platted over one another, and then it is beaten smooth and flat with a wooden Mallet; its use is to *Serve* the Ropes, that is, to keep them from galling.

**SINOPE**, in *Heraldry*, the Green Colour

**SENOPE**, in Coats of Arms, so called by the ancient Heralds.

**SI non omnes**, is a Writ of Association, whereby, if all in Commission cannot meet at the Day assigned, it is allowed, that two, or more of them, may finish the Business.

**SINUS**, in *Surgery*, a small *Sacculus*, or little Bag formed by the side of a Wound or Ulcer, in which the Pus is collected.

**SINUS**, any Cavity in or between the Vessels of an *Animal Body*, the Anatomists call a *Sinus*; and some Philosophical Writers call those Fissures, or Cavities, which are between the several *Strata*, or Layers,



Layers, of the Earth, in Mines, &c. by this Term *Sinus*. For *Sinus* in Mathematicks, see *Sine*.

*SINUS Meningium*, are those three Cavities which *Galen* calls the Ventricles of the thick Membrane. The first and second, or the Lateral *Sinus*, are seated between the Brain and the *Cerebellum*, and end in the Vertebral *Sinus*'s. The third begins from the *Os Cribriforme*, and ends in the Middle of the former *Sinus*'s. The fourth arises from the *Pinealis* Glandule, and ends in the Middle of the Lateral *Sinus*'s. The Insertion of these *Sinus*'s is called *Torcular Herophili*. The *Sinus*'s, after they have passed through the Skull, are partly continued with the Jugular Veins, and partly descend through the whole Length of the Spinal Marrow down to the *Os Sacrum*. The Use of them is to supply the Place of Veins, for they convey the Blood from the Brain and *Cerebellum*, partly into the Jugular Veins, and partly into the Vertebral *Sinus*'s. *Blanchard*. With us the Ventricles of the Brain are accounted only the three Partitions or Subdivisions of the *Fornix*; and they serve as a Sink to drain away the excrementitious Matter of the Brain.

*SINUS Offium*, are those Cavities of the Bones which receive the Heads of other Bones.

*SIPHON*, a Glass, or metalline crooked Pipe, Tube, or Cane. See *Syphon*.

*Si Recognoscant*, is a Writ that lies for a Creditor against his Debtor, for Money number'd, that hath, before the Sheriff in the County-Court, acknowledged himself to owe his Creditor such a Sum, received of him in *pecuniis numeratis*.

*SIRIUS*, the *Dog-star*, a bright Star of the first Magnitude, in the Constellation *Canis Major*: Its Longitude is 99 Degrees, 47 Minutes, Latitude 39 Degrees, 32 Minutes.

*SIRONES*, little Pusles in the Palm of the Hand, and Sole of the Foot, containing certain small Insects, or Worms.

*SITUS*, in *Geometry*, &c. Situation, *i. e.* the Situation of Lines, Surfaces, &c.

*SIXTH*, in *Musick*, is one of the simple Original Concords, or harmonical Intervals. It is of two kinds, *greater* and *lesser*, and hence it is esteemed one of the imperfect Concords, though each of them arises from a Division of the *Octave*. The *greater Sixth* is a Concord that results from a Mixture of the Sound of two Strings, which are to each other as 2 to 5. The *lesser Sixth* results also from two Strings, which are to each other as 5 to 8.

*SIXAIN*, is an ancient Order of Battle for six Battalions, which supposing them all in a Line, is formed thus: The second and fifth Battalions advance and make the *Van*. The first and sixth fall into the *Rear*, leaving the third and fourth to form the main Body. Each Battallion should have a Squadron on its Right, and another on its Left. Any Number of Battalions which are Multiple of six, may be drawn up by this Order, *i. e.* twelve Battalions may be put into two *Sixains*, eighteen Battalions into three, &c.

*SIZING*, is a curious way of *Dressing* the Tin Ore, after it comes from the *Launder* of the Stamping-Mill; which is by sifting it through an Hair Sieve, casting back the Remainder in the Sieve into the *Tails*, to be *Trambled* over again. See *Buddele* and *Tin*.

*SKARFED*, the *Sea Term*, when one Piece of Timber is let and fastened into another. See *Scarfed*.

*SKELETON*, of a Man or other Animal, is when the Bones are cleaned and dry, and put together, according to Art, in their natural Order and Position.

*SKIN*. As soon as the *Cuticula*, or Scarf-Skin, is separated from the *Cutis*, or true Skin, of a humane Body, there are these three Parts appear first, an infinite Number of *Papillæ Pyramidales*, which are the Ends of all the Nerves of the Skin, each of which are enclosed in two or three Covers of a Pyramidal Figure. Between these *Papillæ* are an infinite Number of Holes, which are nothing but the Orifices of the Excretory Vessels of the *Miliary Glands* underneath.

*Secondly*, There appears a Web of Nervous Fibres, and other Vessels, differently interwoven: This is always covered with a mucous Substance, serving to support and moisten the *Papillæ Pyramidales*. And this is the *Parenchyma*, or that Part of the Skin which *Parchment* is made of.

The *third* Part is an infinite Number of *Miliary Glands*, about whom there is much Fat usually: These Glands separate the Matter by Sweat and insensible Perspiration. Each Gland receives a *Nerve* and *Artery*, and sends out a *Vein*, and an *Excretory Duct*; which last passes through the other two Parts to the *Cuticula*, in order to moisten it and the *Papillæ Pyramidales*, lest they should be so dry as to hinder the Sense of Feeling; and also to discharge that Matter out of the Body.

The Use of the Skin is to cover and wrap up all the Parts of the Body; to be the Organ of Touching or Feeling, and to be the Emunctory of the whole Body. For through the Glands of the Skin, pass not only such Particles of the Vessels as decay, by reason of the continual Motion of the Blood, but likewise the greatest Part of the Liquors which we drink; which having perform'd Part of their Office, in conveying the Aliments into the Blood, are in the next Place to dissolve the Saline and Terrestrial Particles to be carried off thro' the Glands of the Skin and Kidneys. *Sanctorius* computes, that about fifty Ounces a Day are thus carried off through the Cutaneous Glands: So that if a Man's Body be supposed to weigh one hundred and sixty Pound in fifty-one Days, he may perspire a Quantity equal to the Weight of his whole Body. *Keil's Anatomy*.

Above the *Cutis*, or thick Skin of the Body, lies the *Cuticula*, or Scarf-Skin, and is composed of several Plaits of small *Scales*, which cover one another, more or less, or lie thicker, according as it is thicker in one Part of the Body than in another: Between these *Scales* the *Excretory Duct* of the *Miliary Glands* of the *Cutis*, or thick Skin, open. *Leewenhoeck* reckons, that round about one *Cuticular* five hundred such Ducts may lie, and that a Grain of Sand will cover two hundred and fifty of these *Scales*: So that one Grain of Sand will cover 125000 Orifices of these little Ducts; and yet into every one of these *Miliary Glands* an Artery, Vein and Nerve do certainly enter. These Glands secrete the Sweat, and what goes off by insensible Perspiration: And they must be very many in Number, since, as *Sanctorius* observes, fifteen Ounces of a Fluid Matter passes in twenty-four Hours time. Next under the Scarf-Skin lie the *Papillæ Pyramidales*, which also



also are prodigiously numerous, being the Extremities of all the Nerves of the Skin, and do more immediately serve for the Sense of Feeling, and to convey the Impulse received, by Means of the Nerves, to the Brain. About these the Nerves, and all other Vessels, make a fine Web, all covered over with a mucous Substance, to moisten these *Papillæ Pyramidales*; and then under these the *Miliary Glands* are placed, protruding their *Secretory Ducts* up to the Surface of the Scarf-Skin; on which there are many Parallel Lines, and these intersected by others, and in each Intersection there is an Hair usually placed. The *Scales* of the Scarf-Skin defend the Orifices of the *Excretory Ducts* of the *Miliary Glands*, and hinder Objects from making too exquisite and painful an Impression upon the Nerves, and so to save them from External Injuries. The Skin itself is designed to enwrap the whole Body, and to sustain the *Papillæ Pyramidales* in their Places, and the *Miliary Glands* from being disordered; also to receive the Impression of external Objects, and to be the Organ of the Sense of Touching and Feeling.

SKUPPERS, and *Skupper-Holes*. See *Scoper-Holes*.

SKY, the blue Air, or Atmosphere. Sir *Isaac Newton* attributes the azure Colour of the Sky to Vapours beginning to condense in it, which have got Consistence enough to reflect the most reflexible Rays, *viz.* the Violet ones, but not enough to reflect the less reflexible ones.

M. *de la Hire* attributes it to our viewing a black Object, *viz.* the dark Space beyond the Regions of the Atmosphere through a white or lucid one, *viz.* the Air illuminated by the Sun; a Mixture of black and white always appearing blue.

SLAM, a Term used in the *Alum-Works*, which see.

SLATCH; when any Rope or Cable hangs slack, the Seamen call the middle Part which hangs down, the *Slatch* of the Cable, or Rope; so also after long foul Weather, if there come a small Interval of Fair, they say, this is a *Slatch* of fair Weather.

SLEDGE, is a large Smith's Hammer to be used with both Hands: Of this there are two sorts, the *Uphand-Sledge*, which is used by under Workmen, when the Work is not of the largest Sort: This is used with both the Hands before; and they seldom raise it higher than their Head. But the other, which is called the *About-Sledge*, and which is used for battering or *drawing out* the largest Work, is held by the Handle with both Hands, and swung round over their Heads, at their Arms-end, to strike as hard a Blow as they can.

SLEEP is defin'd to be that State wherein the Body appears to be perfectly at rest; external Objects move the Organs of Sense as usually, without exciting the usual Sensation.

*Robault* is of Opinion, that Sleep consists in a Scarcity of Spirits, which occasions that the Orifices, or Pores of the Nerves in the Brain, whereby the Spirits used to flow into the Nerves, being no longer kept open by the Frequency of the Spirits, shut themselves.

*Boerhave* defines *Sleep* to be that State of the *Medulla* of the Brain, wherein the Nerves do not receive so copious, nor so forcible an Influx of Spirits from the Brain, as is required to enable the Organs of Sense and voluntary Motion to perform their Offices.

SLEEPERS, Timbers lying before and aft in the Bottom of a Ship, as the Rung-heads do; the lowermost of them is bolted to the *Rung-heads*, and the uppermost to the *Futtocks*, in order to strengthen and fasten the *Futtocks* and *Rungs*.

SLIDING Rules, or Scales, are Instruments to be used without Compasses, in Gauging, Measuring, &c. having their Lines fitted so as to answer Proportions by Inspection; they are very ingeniously contrived and applied by *Gunter*, *Partridge*, *Cogshall*, *Everard*, *Hunt*, and others, who have written particular Treatises about their Use and Application.

SLING, a Word used variously at Sea; there are *Slings* to hoist up Casks, or any other heavy things; which are made of Ropes spliced into themselves at either End, with an Eye big enough to hold the thing to be *slung*.

There are other *Slings*, which are made longer, and with a small Eye at each End, one of which is put over the Breech of a Piece of Ordnance, and the other Eye comes over the End of an Iron Crow, which is put into the Mouth of the Piece, to weigh and hoist the Gun as they please.

There are also *Slings* for the Yards, which is done by binding them fast to the *Cross-tree* aloft, and to the Head of the Mast with a strong Rope, or Chain, that if the Tie should happen to break, or to be shot to Pieces in a Fight, the Yard nevertheless may not fall down upon the Hatches.

SLOOP, is a Vessel of the Shallop-kind. In our Navy such attend upon the Men of War. They are usually about sixty Tun, and carry about thirty Men.

SLUICE, a Frame of Timber, Stone, or other Matter, that serves to retain and raise the Water of a River, &c. and also to let it pass upon Occasion.

SMACK, *Smak* in Latin, is a small Vessel with but one Mast. Sometimes such are employed as Tenders on a Man of War, and they are also used for Fishing upon the Coasts.

SMELLING, is probably occasioned by the *Effluvia* of odorous Bodies mingling themselves with the Air, and entering up the Nostrils, which are covered with a very Nervous and Sensible Coat, and there insinuating themselves into the Processes of the Olfactory Nerve, do move it variously according to their various and different Nature, and so communicate to the Brain such corresponding Motions, as enables the Soul to judge differently of the Bodies emitting such *Effluvia*: And from hence, when the *Effluvia* produces a grateful Sensation, we say it hath a sweet Smell; but when a disagreeable one, we say it stinks.

SMELTING, with *Refiners*, the melting the Metal in the Ore in the Smelting-Furnace, in order to separate the metallick Substance from the earthy.

SMITEING-Line, in a Ship, is a small Rope fastened to the Mizzen-yard-arm, below at the Deck, and is always furled up with the Mizzen-sail, even to the upper End of the Yard, and from thence it comes down to the Poop. Its Use is to loose the Mizzen-sail, without striking down the Yard, which is easily done, because the Mizzen-sail is furled up only with Rope-yarns; and therefore when this Rope is pulled hard, it breaks all the Rope-yarns, and so the Sail falls down of itself: The Word of Art is, *Smite the Mizzen* (whence this



this Rope takes its Name;) that is, hale by this Rope, that the Sail may fall down.

SMOKE, in *Physicks*, a humid Matter, exhaled in the Form of a Vapour, by the Action of Heat either external or internal.

Sir *Isaac Newton* observes, that *Smoke* ascends in Chimneys by the Impulse of the Air it floats in; for that Air being rarified by the Fire underneath, hath its Specifick Gravity diminished; thus being determined to ascend itself, it carries up the Smoke along with it. The same Author supposes the Tail of a Comet to ascend from the Sun after the same manner.

SMOKE-*Farthings*, the Pentecostals, or Customary Oblations offered by the Inhabitants within any Diocess, when they made their Processions to the Mother or Cathedral Church, and came by degrees into an annual standing Rent, called *Smoke-Farthings*.

SNATCH-Block, is a great Block in a Ship, with a Shiver in it, having a Notch cut through one of its Cheeks, for the more ready receiving in of any Rope: For by this Notch, the middle Part of a Rope may be reeved into this Block, without passing it in End-ways. This ready Block is commonly fastened with a Strap about the Main-mast, close to the Upper Deck, and is chiefly used for the Fall of the *Winding Tackle*, which is reeved into this Block, and then brought to the Capstan.

SNEEZING, a convulsive Motion of the Muscles of the Breast, used in Expiration, in which, after the suspending the Inspiration begun, the Air is expell'd from the Mouth and Nose with a momentary Violence. The Cause is the Irritation of the upper Membrane of the Nose, which communicates with the Intercostal Nerve by Means of the Twigs that it detaches to it.

SNOW. The learned Dr. *Grew*, in *Philosophical Transactions*, Numb. 92, gives the following Account of *Snow*, which seems very exact and just.

1. With Mr. *Des Cartes*, and Dr. *Hook*, he observes, That many Parts hereof are of a regular Figure; for the most Part being as it were so many little Rowels, or Stars of six Points; being perfect and transparent Ice, as any one may see upon a Pool, or Vessel of Water; upon each of which six Points, are set other collateral Points, and those always at the same Angles, as are the main Points themselves.

2. Amongst these Regular Figures, though many of them are large and fair; yet from these, taking our first *Item*, many others, alike regular, but far less, may likewise be discovered.

3. Amongst these, not only regular, [but entire Parts of Snow, looking still more warily, we shall perceive, that there are diverse others indeed irregular, which yet are chiefly the broken Points, Parcels, and Fragments of the regular ones.

4. That besides the broken Parts, there are some others which seem to have lost their Regularity, not so much in being broken, as by various Winds, first gently thaw'd, and then froze into little irregular Clumpers again.

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From whence the true Notion, and external Nature of *Snow*, seemeth to appear, viz. That not only some few Parts of *Snow*, but originally the whole Body of it, or of a *Snowy Cloud*, is an infinite Mass of Icicles regularly figured; not one Particle thereof, I say, originally, not one of so many Millions, being indetermined, or irregular; that is to say, a Cloud of Vapours being gathered into Drops, the said Drops forthwith descend; upon which Descent, meeting with a soft freezing Wind, or at least passing through a colder Region of the Air, each Drop is immediately froze into an Icicle, shooting itself forth into several Points, or *Stirix*, on each Hand fromward its Centre: But still continuing their Descent, and meeting with some sprinkling and intermixing Gales of warmer Air, or in their continual Motion and Waftage to and fro, touching upon each other; some are a little thaw'd, blunted, frosted, clumper'd, others broken, but the most hanked and clung in several Parcels together, which we call Flakes of *Snow*.

It being known what *Snow* is, we understand why, though it seem to be soft, yet 'tis truly hard: because true Ice, the inseparable Property whereof is to be hard, seeming only to be soft, because upon the first Touch of the Finger, upon any of its sharp Edges or Points, they instantly thaw; or otherwise they would pierce our Fingers as so many Lancets.

Why, again, though *Snow* be true Ice, and so hard and dense a Body, yet very light; because of the extream Thinness of each Icicle in Comparison of its Breadth. For so Gold, which though of all Bodies it be the most ponderous, yet being beaten into Leaves, rides upon the least Breath of Air; and so in all other Bodies, where there is but little Matter contained within large Dimensions, and possibly in no other Case.

Also, how it is *White*, not because hard; for there are many soft Bodies *White*; but because consisting of Parts, all of them singly transparent, but being mixt together appear *White*; as the Parts of Froth, Glass, Ice, and other transparent Bodies, whether soft or hard.

Thus much for the *External Nature* of *Snow*; let us next enquire into its *Essential Nature*.

Now to make a Judgment of this, is by considering what the general Figure of *Snow* is, and comparing the same with such Regular Figures as we see in divers other Bodies, in that where we see the like Configurations, we may believe there is the like Subject wherein, or the like Efficient whereby both those and these are made.

As for the Figure of *Snow*, 'tis generally one, viz. that which is above described; rarely of different ones, which may be reduced chiefly to two general Circulars and Hexagonals, either Simple or compounded together, more rarely, either to be seen of more than six Points; but if so, then not of eight or ten, but twelve. Or in single Shoots, as so many short, slender Cylinders, like those of *Nitre*. Or by one of those Shoots, as the Axletree, and touching upon the Centre of a Pair of pointed Icicles, joined together as the two Wheels. Or the same Hexagonal Figure, and of the same usual Breadth; but continued in Thickness and Profundity. All these are rare, the first described being the general Figure.



As for the Configuration of other Bodies, we shall find, that there are divers which have some a less, others a more near Resemblance thereto. *Nitre* is formed, as is commonly known, in long Cylindrical Shoots, as also all *Lixivial Salts*, for the most part resembling, tho' not perfectly, the several Points of each Starry Icicle of *Snow*. *Salt of Hart's-horn*, *Sal-Armoniack*, and some other Volatile Salts, besides their main and longer Shoots, have others shorter branched out from them, resembling as those the main, so these the collateral Points of the *Snow*, but the Icicles of *Urine* are still more near: For in *Salt of Hart's-horn*, altho' the collateral Shoots stand at acute Angles with the main, yet not by Pairs at equal Height: And in *Sal-Armoniack*, altho' they stand diametrically opposite, or at equal Height; yet withal at right, not acute Angles: Whereas in the Icicles of *Urine*, they stand at equal Heights, and at acute Angles both; in both like those of *Snow*. And it is observable, that the Configuration of *Feathers* is likewise the same. The Reason whereof is, because Fowls having no Organs for Evacuation of *Urine*, the Urinous Parts of their Blood are evacuated by the Habit, or Skin, where they produce and nourish *Feathers*.

From whence it should seem, that every Drop of Rain aforesaid, containing in itself some spirituous Particles (as from the Height to which they are advanced, the prolific Vertue of Rain, and its easy Tendency to Putrefaction, above other Water, is argued they do) and meeting with others in their Descent, of a Saline, and that partly Nitrous, but chiefly Urinous, or of an *acide-salinous* Nature; the said spirituous Parts are apprehended by them, and with those the watry; and so the whole Drop is fix'd, yet not into any indifferent and irregular Shape, depriving their spirituous Parts of their Motion in an instant; but according to the Energy of the Spirituous, as the Pencil, and the specific Nature, or determinate Possibility of the saline Parts, as the Ruler, 'tis thus figur'd into a little Star.

These things somewhat further considered and cleared, may add a little to that great deal of Light which the Honourable Mr. *Boyle* hath given to the Nature of Gold, the Air, and the Bodies therein contained, in his excellent Discourses thereon.

**SOC**, is a Word signifying a Power, or Liberty of Jurisdiction; whence comes the Law Latin Word *Socā*, for a Seignory enfranchised by the King, with Liberty of holding a Court of his *Sockmen*, or *Socagers*; that is, his Tenants, whose Tenure is hence called *Socage*.

**SOCAGE**, is a Tenure of Lands by, or for certain inferior Services of Husbandry to be performed to the Lord of the Fee, or is a Tenure of Lands, when a Man is infeoffed freely without any Service; Word, Relief, or Marriage, and pays to his Lord such Duty as is called *Petit Sergeantry*, &c.

There is also *Free*, or *Common Socage*, and *Base Socage*, or *Villanage*.

Other Divisions thereof there are in Law Books: But by the Statute 12 *Car. 2. cap. 24.* all Tenures shall be adjudged and taken, to be turned into *free* and *common Socage*.

**SOCLE**,  $\angle$  in *Architecture*, is a flat; square  
**ZOCLE**,  $\int$  Member under the Bases of Pede-

stals of Statues, Vases, &c. to which it serves as a Foot or Stand.

*A Continued SOCLE*, is a sort of continued Stand, or Pedestal, without either Base or Cornice, ranging round the whole Building.

**SOCMANS**, or *Sokemans*, are such Tenants as hold their Lands and Tenements by *Socage* Tenure.

**SOFITTO**, is the *Italian* Term in Architecture for the *Eaves* of the *Corona* of the Capital of a Column.

**SOL**, in *Musick*, the fifth Note of the Gamut, *ut, re, mi, fa, sol.*

**SOL**, in *Hermetick Philosophy*, signifies Sulphur.

**SOL**, in *Chymistry*, signifies Gold, and is so called from an Opinion, that this Metal is in a particular manner under the Influence of the Sun.

**SOLÆUS**, is a Muscle that helps to extend the Foot

**SOLAR Comet.** See *Discus*.

**SOLAR Cyclē.** See *Cycle of the Sun*.

**SOLAR Spots.** See *Spots of the Sun*.

**SOLAR Year**, is either *Tropical*, or *Siderial*.

*Tropical Year*, is that Space of Time, wherein the *Sun* returns again to the same Equinoctial, or Solstitial Point, which is always equal to 365 Days, 5 Hours, and about 55 Minutes.

The *Siderial Year*, is the Space wherein the *Sun* comes back to any particular Fixed Star, which is about 365 Days, 8 Hours, and 9 Minutes.

**SOLE Tenant**, is he or she that holds only in his or her own Right, without any other joined: As, if a Man and his Wife hold Land for their Lives, the Remainder to the Son; here the Man dying, the Lord shall not have Heriot, because he dieth not *Sole-Tenant*.

**SOLET & Debet.** See *Debet & Solet*.

**SOLID**, in *Physicks*, is a Body, the minute Parts of which are connected together so as to slip from each other upon the smallest Impression.

**SOLID**, in *Geometry*, is the third Species of Magnitude, having three Dimensions, Length, Breadth, and Thickness; and is frequently used in the same Sense with Body. It may be conceived to be formed by the direct Motion, or the Revolution of any Superficies, of what Nature or Figure soever.

**SOLIDS Regular**, are such as are terminated by regular and equal Planes, as the *Tetraedron*, *Hexaedron*, *Octaedron*, *Dodecaedron*, *Icosiedron*.

**SOLIDS Irregular**, are all those which do not come under the Definition of the *Regular Solids*, as the *Sphere*, *Cylinder*, *Cone*, *Parallelogram*, *Prism*, *Parallelopiped*, *Pyramid*.

**SOLID Angle**, is an Angle made by the meeting of three or more Planes, and those joining in a Point, like the Point of a Diamond well cut.

**SOLID Bastion.** See *Bastion*.

**SOLID Numbers**, are those which arise from the Multiplication of a *Plane Number*, by any other whatsoever; as 18 is a *solid Number* made of 6 (which is *Plane*) multiplied by 3; or of 9 multiplied by 2.

**SOLID Place.** See *Place solid*.

**SOLID Problem**, in *Mathematicks*, is one which cannot be Geometrically solved, but by the Intersection of a Circle and a Conick Section; or by the Intersection of two other Conick Sections besides the Circle.



As, *To describe an Iſoſceles Triangle on a given Right Line, whoſe Angle at the Baſe ſhall be triple to that at the Vertex.*

This will help to inſcribe a Regular Heptagon, in a given Circle, and may be reſolved by the Interſection of a *Parabola* and a Circle.

The following Problem alſo helps to inſcribe a *Nonagon* in a Circle; and may be ſolved by the Interſection of a *Parabola*, and an *Hyperbola* between its *Aſymptotes*, viz.

*To deſcribe an Iſoſceles Triangle, whoſe Angle at the Baſe ſhall be Quadruple of that at the Vertex.*

And ſuch a Problem as this hath four Solutions, and no more; becauſe two Conick Sections can cut one another but in four Points.

How all ſuch Problems are conſtructed, Dr. Halley ſhews in *Philoſophical Transactions*, Numb. 188.

**SOLIDITY** (ſee *Firmneſs*) is a Quality of a natural Body contrary to Fluidity, and appears to conſiſt in the Parts of Bodies being interwoven and entangled one with another, ſo that they cannot diſſuſe themſelves ſeveral ways, as fluid Bodies can.

**SOLIDITY**, in *Geometry*, is the Quantity of Space that is contained in a ſolid Body, which is alſo called the *Solid Content* or *Cube* of it.

The *Solidity* of a *Cube*, *Prism*, *Cylinder*, or *Parallelopiped*, is gotten by multiplying their Baſes into their Height, or the whole Height.

The *Solidity* of a *Pyramid* or *Cone* is gotten by multiplying either the whole Baſe into a third Part of the Height, or the whole Height into the third Part of the Baſe.

**SOLIDS.** There are uſually placed on the *Sector* two Lines (one on each Leg) which are called by *Gunter*, very properly, the *Lines of Solids*. Theſe are graduated, either by finding two mean Proportionals between the whole Side, and each thouſandth Part of the like Side, all of them cutting the ſame two right Lines; and then the former of the two Lines ſo cut, ſhall contain the Diviſions required. Or the Lines of Solids may be made out of the Line of Lines (or rather out of a Diagonal Scale, equal to it in Length) by a Table of Cubick Roots, and this is the readieſt way; for the Roots taken out of the Scale of equal Parts, ſhall give the Cubes in the Lines of Solids. *E. gr.* To inſcribe the Place 125 in the Line of Solids, affix 12 Cyphers to it, and then extract the Cubick Root, which will be 50000; and that taken out of the Line of Lines, will find the Point of 125 in the Line of Solids, &c.

#### *The Uſe of the Lines of Solids.*

1. *To find the Proportion between two or more Similar Solids.*

In the Sphere, in regular Parallels, and other like Bodies, whoſe Sides adjoining to the equal Angles are proportional; proceed thus: Take one of the Sides of the greater or greateſt Solid, and open the *Sector* to it in the Points of 10 and 10, in the Line of Solids: And then taking the like Sides of the leſſer Solids ſeverally, and carrying them parallel to the former, 'till the Feet of the

Compaſſes ſtay in like Points; the Numbers belonging to thoſe Points will expreſs the Proportions to 1000; that is, the Solids will be to each other as theſe Numbers are to 1000.

2. *To Augment or Diminiſh a Solid in a given Ratio; as ſuppoſe in that of 2 to 3.*

Open the *Sector* to the Side of the Solid given in the Points 2 of the Number given; and then keeping it at that Angle, the Parallel Diſtance between 3 and 3, the Points of the Number required, ſhall give the like Side of a Solid ſimilar to the former, and in the *Ratio* required.

3. *To Add or Subſtract one Solid to, or from another.*

Find the *Ratio* between them (by *Prob. i.*) and then add or ſubſtract thoſe Proportions, and accordingly augment or diminiſh (by the Precedent). Thus, if A and B be the Sides of two Cubes to be added or ſubſtracted; I firſt find the Proportion of A to B to be, ſuppoſe as 100 to 40, or as 5 to 2; then adding 5 to 2, it makes 7; wherefore I augment the Side A in the *Ratio* of 5 to 7, which will give a new Side, as C, on which a Cube being made, will be equal to them both. Proceed *vice verſa* in Subſtraction.

4. *To find two mean Proportionals between two given Lines; as ſuppoſe between A and D.*

Firſt find (by the Line of Lines) the *Ratio* between the two given Lines, which are the Extreams, and let that be in Numbers, as 27 to 8; and then open the Line of Solids on the *Sector*, ſo that the greater Extream A may be applied in the Points 27 and 27. Then keeping the *Sector* at that Angle, take the Diſtance between 8 and 8, and that ſhall give you B, ſuppoſe the former of the two Means. Next apply that Mean B over in the Line of Solids on the Points 27 and 27, and then the parallel Diſtance between 8 and 8 will give you C, the other Mean ſought.

5. *To find two mean Proportionals between two Numbers given: Suppoſe between 27 and 8.*

Reckon 27 and 8 on both Sides, in the Lines of Solids from the Centre. Then taking 27 from the Centre alſo in the Line of Lines, put it over in the Line of Solids in the Points 27 and 27. So ſhall the parallel Diſtance between 8 and 8 in that Line, reckoned in the Line of Lines from the Centre, give 18, the former of the two Means ſought. Apply over then 18 between 27 and 27 in the Line of Solids, and keeping the *Sector* at that Angle, the Parallel between 8 and 8 in the ſame Line, will give a Length to be reckoned, as before; on the Line of Lines from the Centre, which will be 12, the latter mean Proportional required.

6. *To find the Cubick Root of a Number given, or the Cube of a Number assigned.*

In the Extraction of the Cube Root, you muſt point from the Right Hand towards the Left, the firſt, and then every third Place; and then there will be as many Places in the Root, as there are ſuch Points over the Cube Number given. Wherefore if the Number be under 1000, the Root can conſiſt



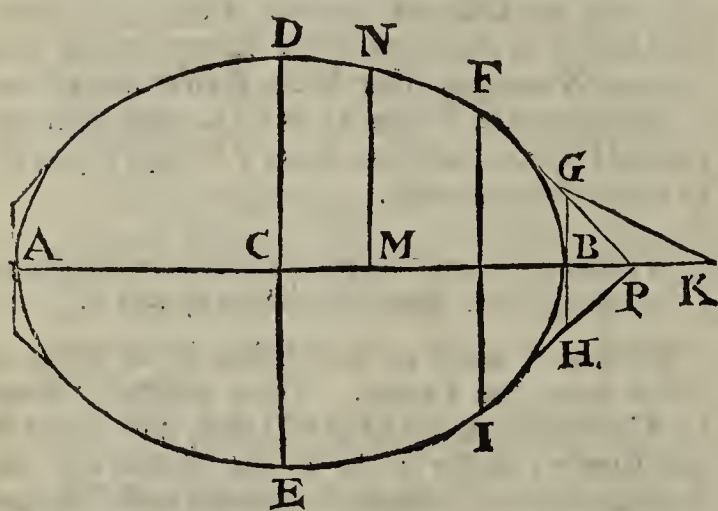
confist but of one Figure. If less than 100000, it can confist but of two Places; and if less than 1000000000, it will have but three Places in the Root, &c. Wherefore the Line of Solids is divided first into 1000 unequal Parts: And therefore if the Number given be greater than 1000, the first Division of the Line, which before signified but one, will now stand for 1000, &c. as in the Line of Numbers. By this Means, if the last Point over a Cubick Number fall on the last Figure to the Left Hand, the Number given shall be reckoned on the Line of Solids from 1 to 10, and the first Figure of the Root will be either 1 or 2. But if the Point fall on the last Figure but one, the Number given must be accounted in the Middle of the Line of Solids, between 10 and 100, and the first Figure of the Root will be always either 2, 3, or 4. And if the last Point stand over the last Figure but two, then the Number given shall be accounted at the End of the Line of Solids, between 100 and 1000.

This being premised, the Extraction of the Cube Root will be easy, without opening the Sector: Set one Foot in the Sector, and extend the other to the Point representing the Numbers. That Distance will reach in the Line of Lines from the Centre to the Root.

Thus the nearest Root of 8490000 is about 204  
 of 84900000 — 439  
 of 849000000 — 947

And the Extent from the Centre of the Line of Lines to any Number for a Root, will reach in the Solids from the Centre to the Cube.

SOLID of least Resistance. Sir Isaac Newton, in his *Principia*, pag. 327, shews, That if



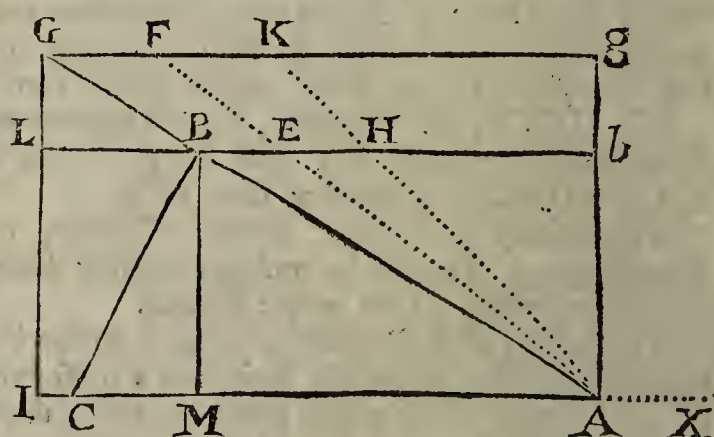
there be a Curve Figure, as D N F B, of such a Nature, as that from any Point, as N, taken in its Circumference, a Perpendicular be let fall to the Axis, as N M: And if from a given Point, as G, the Right Line G R be drawn parallel to a Tangent to the Curve in that Point; and also if the Axis being produced 'till G R cut it, it then be as  $M N : G R :: G R^3 : \frac{N}{4 B R} \times G B^2$ . Then

the Solid, which may be generated by the Revolution of this Curve round its Axis A B, when moved most swiftly in a rare and elastick Medium, shall meet with less Resistance from the Medium, than any circular Solid whatsoever, described after the same manner, and whose Length and Breadth are the same.

After this, in the Year 1699, Monf. the Marquis de l'Hospital, produced an easy Method of finding a round Solid, which being placed in a Fluid, whose Parts are at rest, shall, when moved in that Fluid parallel to its Axis, meet with less Resistance from the Medium, than any Solid whatever, whose Length and Breadth are the same, and which shall be moved with the same Velocity.

And this he doth by finding a Curve, which revolving round its Axis, shall generate the Surface of such a Solid. See *Memoires de l'Academ. Royale des Sciences*, 1699. In the latter end of the Year 1700, Mr. John Craig sent to the Publisher of the *Philosophical Transact.* a Latin Letter, in which there is a Solution of this Problem, of finding the Solid of least Resistance. (See *Philosoph. Transact.* Numb. 268.) and which is introduced by this Lemma.

To find the Ratio between the Resistance of the Right Angled Triangle A I G, and the Rectangle A I G g, circumscribing it, when each is moved in a Fluid, according to the Direction of the Line I A, from I towards X.



From any Point, as B, draw the right Line B C, perpendicular to the Diagonal G A, B b parallel to A I, and also B M normal to A I; then take in  $B b, b H = \frac{C M^2}{B C}$ , and  $b E = B C$ ; and thro' the Points H, E, let the right Lines H A, E A, be produced 'till they cut G g in K and in F.

Then, I say, that the Resistance of the Triangle A I G is to the Resistance of the Rectangle A I G g, as the Area of the Triangle A K G is to the Area of the Triangle A F g, and the Resistance in any Part of the Line A G is to the Resistance in the corresponding Part of the Line A g (suppose in A B and A b, &c.) :: as the Area A H B to the Area A E B. The Demonstration of this depends on a general Theorem, which I did very easily deduce from the 35 Prop. of Sir Isaac Newton's *Princip.* pag. 324.

Cor. 1. Let B G and b g be infinitely small Parts of the Lines A G and A g, and produce b B to L; then, I say, that the Resistance in B G (which let us call e) is to the Resistance in b g (which call E) as  $G L^2$  is to  $G B^2$

For  $e : E :: K H b g : F E b g$ ; that is,  $e : E :: b g \times b H : b g \times b E$  (by the preceding Lemma) wherefore  $e : E :: b H : b E$  (that is)  $e : E :: \frac{C M^2}{B C} : B C$  (by the Construction of that Lemma) wherefore  $e : E :: C M^2 : B C^2$ . But  $C M^2 : B C^2 :: G L^2 : G B^2$  (from the similar Triangles B M C, G L B) wherefore  $e : E :: G L^2 : G B^2$ . Q. E. D.

Cor. 2.



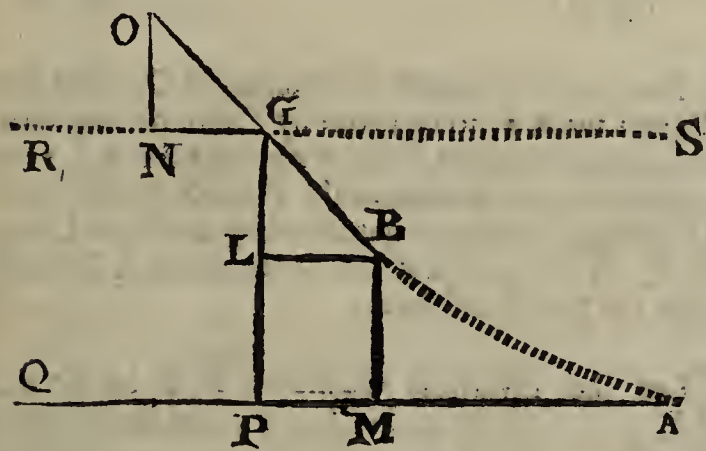
Cor. 2. *The Resistance against the infinitely small Part G B, is equal to the Cube of the Line G L, divided by the Square of the Line G B.* For if all the infinitely small Parts of the Line A g (as  $bg$ , &c.) be supposed equal; then the Resistance in  $bg$  might be expressed by  $bg$ ; that is,  $E = bg$ ; and therefore  $E = GL$ . Wherefore, by Cor. 1.  $e : GL :: GL^2 : GB^2$ ; wherefore  $e = \frac{GL^3}{GB^2}$ . Q. E. D.

Cor. 3. Let  $r$  be Radius, and  $c$  the Circumference of any Circle; I say, the Resistance against the Conical Surface, generated by the Rotation of the *Lineola*  $GB$ , round about  $AI$ , is equal to the Product of  $\frac{c \times BM}{r}$  into  $\frac{GL^3}{GB^2}$ : for the Resistance against that Conick Surface is equal to all the Resistances against the *Lineola*  $GB$ ; that is, to all the  $e$ . That is, 'tis equal to the Circumference of the Circle whose Radius is  $BM$  multiplied by  $e$ . That is, the Resistance against that Conick Surface, is equal to  $\frac{c \times BM}{r} \times e$ ; wherefore by

Cor. 2. it is equal to  $\frac{c \times BM}{r} \times \frac{GL^3}{BG^2}$ . Q. E. D.

Then follows the Problem proposed, which is this :

*Problem.* To find the Curve, by whose Rotation round an Axis, a round Solid shall be produc'd, which, supposing to be moved in a Fluid, according to the Direction of the said Axis, shall suffer the least possible Resistance in that Medium.



Suppose O G, G B, two infinitely small Parts in the Curve required, by whose Rotation round the Axis A Q, the *Solid of least Resistance* is generated. Let B M, G B be drawn at right Angles to A Q, and draw B L parallel to A Q, and O N parallel to B M. It is then plain, that

$$\frac{c \times B M \times G L^3}{r \times G B^2}$$

is the Resistance against the Surface generated by the Rotation of the *Lineola* G B about the Axis A Q; and that

$$\frac{c \times G P \times O N^3}{r \times O G^2}$$

is the Resistance against that generated in like manner by O G, from *Cor. 3.* of the preceding *Lemma*. Now both these Resistances taken together, must be the least possible: Wherefore

$$\frac{c \times B M \times G L}{r \times G B^2} + \frac{c \times G P \times O N^3}{r \times O G^2} = \text{a Minimum,}$$

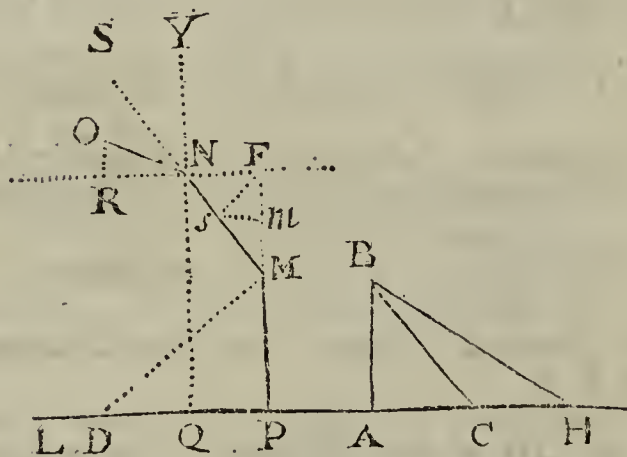
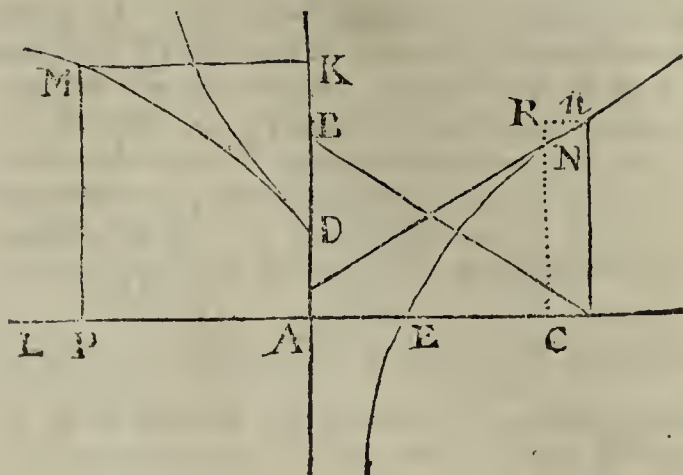
or to the least possible Resistance. And consequently in the Line RS (which must be drawn parallel to AQ, so that ON = GL) the Point G is to be investigated, where this will happen. And supposing O and B fixed Points, this will easily be found by the Method *de Maximis & Minimis*. And producing the *Calculus*, it will come at last to stand thus;  $\frac{BM \times BL}{BG^4} = \frac{GP \times NG}{OG^2}$ .

Wherefore 'tis plain, that  $\frac{B M \times B L}{B G^4}$  is an invariable Quantity. So that if the Abscissa  $A M$  be called  $x$ , and the Ordinate  $B M = y$ , then  $B L$  will be  $= \dot{x}$  and  $G L = \dot{y}$  (which in this whole *Calculus*, I suppose *invariable*) whereof  $B G^2 = \dot{x} \dot{x} \times \dot{y} \dot{y}$ . Wherefore  $\frac{\dot{y} x}{\dot{x} \dot{x} \times \dot{y} \dot{y}^2}$  will be an invariable Quantity. Let then  $a$  be an invariable Line, and then, according to the Laws of Homogeneals, it will be  $\frac{y \dot{x}}{\dot{x} \dot{x} \times \dot{y} \dot{y}^2} = \frac{a}{y^2}$ , as was discovered by the famous *L' Hospital*, and *James Bournouilli*, *Q. E. I.*

**SOLID** of least Resistance. The wonderful Sir *Isaac Newton*, in his excellent Treatise, *De Princip. Philosoph. Mathemat. l. 2. Sect. 7.* gives us, in *Prop. 35.* and *Schol. of Lib. 2.* the Property of a *Curve*, as *D M*; which being supposed to revolve about its *Axis A L*, shall generate a *Solid*, whose resistance, when moved in any Fluid, whose Particles are at rest, according to the Direction of the said *Axis*, from *L* to *A*, shall be the least possible; that is, the solid shall meet with less Resistance from the Fluid, than any other generated by any other *Curve* described to the same *Axis A L*, and passing through the given Points *D M*.

The Excellence and Usefulness of this Problem, especially as to the Figure of the Bodies of Ships, did engage several eminent Mathematicians to consider it fully, and (because the great Author had concealed his own) to communicate several Methods of Investigation of this Curve: As the Noble Marquis *de L'Hospital*, Mr. *John Bernouilli*, Mr. *John Craig*, and *M. Fatio*, have already done. From whence the Industrious Mr. *Hayes*, in his Book of *Fluxions*, pag. 147, extracts the following Solution :





*To investigate the Nature of that Curve which shall generate the Solid of least Resistance.*

Imagine the little Lines  $M N$ ,  $N O$  to be two Sides of the Infinito-lateral Polygon, which constitutes the Curve required: Draw  $M P$ ,  $N Q$  Ordinates to the Axis  $A L$ , and draw  $R N F$  parallel to the same Axis  $A L$ , and let  $O R$ ,  $M F$  be perpendicular to  $R N F$ , and  $M D$  perpendicular to the Side  $M N$ .

Then 'tis evident, that if the Right Lines  $MN$ ,  $NF$  move in the Direction of the Axis from  $L$  towards  $A$ ; that the Force of Resistance of the Fluid, in such a Case, is equal to the Action of the Fluid moving in the same Direction from  $A$  towards  $L$  (and with the same Velocity). On the said Lines  $MN$ ,  $MF$ , being Quiescent, draw  $FS$  perpendicular to  $MN$ , and then the Triangles  $FSN$ ,  $FMN$ ,  $PM D$  are similar; therefore if  $FN$  represent the Force of a Particle of the Fluid to move the Line  $FM$  in the Direction of  $AL$ , from  $A$  towards  $L$ , then  $FS$  will represent the Force of the same Particle of the Fluid to move the Line  $MN$  in the Direction of  $MD$ , from  $M$  towards  $D$ ; that is, the Force of the Particle to move  $M$  from  $FA$  towards  $L$ , is to the Force of the same Particle to move  $MN$ , from  $M$  toward  $D :: FN : FS :: MD : DP$ . Again, if  $MD$  represent the Force of the same Particle to move  $MN$  from  $M$  towards  $D$ , then  $DP$  will represent the Force of the same Particle to move  $MN$  in the Direction of  $DP$ , from  $P$  towards  $D$ ; therefore the Force of the Particle of the Fluid to move  $MF$ , from  $A$  towards  $L$ , is to the Force of the same Particle to move  $MN$  from  $A$  towards  $L :: \overline{DM^2} : \overline{DP^2} :: \overline{MN^2} : \overline{FM^2}$ . The Proportion between the Force of the Particle of the Fluid to move  $MF$  (or  $Qv$ ) from  $A$  towards  $L$ , and the Force of the same Particle to move  $MN$  from  $A$  towards  $L$ , may be found thus: If  $FN$  represent the Force of the Particle against  $QNv$  in the Direction from  $A$  to-

wards  $L$ , then  $FS$  will represent the Force of the same Particle against  $MN$  in the Direction of  $MD$ ; and if  $FS$  represent the Force of the Particle against  $MN$  from  $M$  towards  $D$ , then  $mS$  will represent the Force of the same Particle against  $MN$  in the Direction of  $AL$  from  $A$  towards  $L$ : therefore the Force of the Particle of the Fluid to move  $MF$  (or  $QN$ ) from  $A$  towards  $L$ , is to the Force of the same Particle to move  $MN$  from  $A$  towards  $L$ , as  $EN$  is to  $mS$ ; that is, as  $FNq$  is to  $FSq$ , or as  $MDq$  is to  $DPq$ .

Whence, if the given right Line  $AB$  ( $a$ ) represent the Velocity of the Particles of the Fluid striking against the Right Lines  $MN$ ,  $MF$ ; then the Force of the same Fluid upon the Place described by  $MF$  revolving about the Axis  $AL$  at the Distance  $MP$ , and directly opposed to the Motion of the Fluid, will be as the Surface described, and Velocity jointly; that is, as  $a \times MF \times MP$ ; whence to find (from  $A$  towards  $Q$ ) the Force of the Fluid on the Surface  $MN$ ; say,  $\overline{MN^2}$ .

$$\overline{FM^2} :: a \times MF \times MP : \frac{a \times \overline{MF^3} \times MP}{MN^2} =$$

to the Force (in the Direction of  $AL$  from  $A$  towards  $L$ ) of the Fluid on the Oblique Surface described by the Rotation of  $MN$  about the Axis  $AL$ ; or, which is the same thing, the Quantity

$\frac{a \times \overline{M P^3} \times \overline{M P}}{M N^2}$  expressing the Resistance which

the same Surface, moving from L towards A, suffers from the Fluid at rest. In like manner the Resistance, which the Surface described by NO revolving about the Axis AL, meets with from the quiescent Fluid, may be represented by

$$\frac{a \times \overline{OR^3} \times NQ}{\overline{NO^2}}.$$

Now, if we suppose the Points  $M O$ , and the Right Line  $R F$ , to be given by Position, and that they are in the same Plane with the Axis  $A L$ ; it remains only to determine the Point  $N$  in the Line  $R F$ , so that the Surface generated by the Right Lines  $M N$ ,  $N O$  revolving about the Axis  $A L$  shall suffer the least Resistance.

Let the invariable Quantities  $MF = m$ ,  $MP = r$ ,  $OR = n$ ,  $NQ = q$ ; and the variable Quantities  $FN = v$ , and  $NR = z$ ; then  $MN^2 = mm + vv$ , and  $NO^2 = nn \times zz$ ; therefore the Resistance which the Surface described by the Line  $MN$  meets with, viz.  $\frac{a \times MF^3 \times MP}{MN^2}$

is  $= \frac{a + m^2 \times r}{m m + v v}$ , and that which the Surface described by NO (revolving about the Axis AL) viz.  $\frac{a \times \overline{O R^3} \times N Q}{N O^2}$  is  $= \frac{a \times n^3 \times q}{n n + z z}$ ; whence

it is evident (from the Nature of the Question) that the Quantity  $\frac{a \times m^3 \times r}{m m + v v} + \frac{a \times n^3 \times q}{n n + z z}$  ought to be a *Minimum*, and (*Art.* 198.) consequently the Fluxions thereof must = 0. Whence  $\frac{2 m^5 r \times v v}{m m + v v^2} = \frac{2 n n g \times z z}{n n + z z^2}$ . Now because



$vz +$  is  $= RF$ , an Invariable Quantity, therefore  
 $\dot{v} = -\dot{z}$ , and consequently  $\frac{m^3 \times r \times v}{m m + v v^2} =$

$\frac{n^3 \times q \times z}{n n + z z^2}$ . Whence if  $AB(a)$  be erected perpendicular to the Axis  $AL$ , and if the right Lines  $BC, BH$ , be drawn parallel to the infinitely little Sides  $MN, NO$ , it will be  $4 AB \times AC : BC^3 :: BC : MP$ ; and in like manner  $4 AB^2 \times AH : BH^3 :: BH : NQ$ ; for because the Triangles  $MFN, BAC$  are similar, therefore  $AC = \frac{a n}{m}$ , and  $BC = \frac{a \times m m + v v^{\frac{1}{2}}}{m}$ ; whence

$4 AB^2 \times AC \left( \frac{4 a^3 v}{m} \right) : BC^3 \left( \frac{a^3 \times m m + v v^{\frac{1}{2}}}{m^3} \right)$   
 $:: BC \left( \frac{a \times m m + v v^{\frac{1}{2}}}{m} \right) : MP(r)$  and conse-

quently  $\frac{r m^3 v}{m m + v v^2} = \frac{1}{4} a$ . In like manner, because the Triangles  $ORN, BAH$ , are similar,  $AH = \frac{a z}{n}$ , and  $BH = \frac{a \times n n + z z^{\frac{1}{2}}}{n}$ . Whence

$4 AB^2 \times AH \left( \frac{4 a^3 z}{n} \right) : BH^3 \left( \frac{a^3 \times n n + z z^{\frac{1}{2}}}{n^3} \right)$   
 $:: BH \left( \frac{a \times n n + z z^{\frac{1}{2}}}{n} \right) : NQ = q$ . Whence

$\frac{q n^3 z}{n n + z z^2} = \frac{1}{4} a$ ; and consequently,  $\frac{m^3 \times r \times v}{m m + v v^2} =$

$\frac{n^3 \times q \times z}{n n + z z^2}$ . Which is the very same Equation that we first found.

Whence 'tis manifest, that the Nature of the Curve  $MD$  (which being revolved about its Axis  $AL$ , generates the Solid of least Resistance) is such, that drawing  $AK$  perpendicular to the Axis  $AL$ , and taking  $AB = a$ , and drawing  $BC$  parallel to any Tangent of the Curve, *v. g.* in the Point  $M$ , then will it always be  $4 AB \times AC : BC^3 :: BC : MP$ , the Ordinate passing thro' the Point  $M$ , which is the Property of the Curve that generates the Solid of least Resistance, discovered by Sir Isaac Newton.

And having thus discover'd the Property of the Curve  $MD$ , it may be constructed by Help of the Logarithmetical Line in this manner:

In the Perpendicular  $AK$  assume  $AB = a$ , and in the Axis  $AL$  produc'd, take  $AE = \sqrt{\frac{1}{3}} a$ , and through the Point  $E$  describe the Logarithmetical Line  $EN$ , and let  $AK$  be the Asymptote, and  $\frac{1}{4} a$  the Sub-tangent; then take  $AC$  at pleasure, which suppose  $= z$ , and draw  $CN$  parallel to  $AK$ , 'till it meet in the Logarithmetical Curve in

$N$ ; then if  $AK$  be taken  $= \frac{a a}{4 z} + \frac{1}{2} + \frac{z^3}{4 a a}$ , and

$AP = \frac{z z}{4 a} + \frac{3 z^4}{16 a^3} - \frac{s a}{48} + CN$  (*viz.*  $+ CN$ ,

when  $AC > AE$  and  $-CN$  when  $AC < AE$ ) and compleat the Parallelogram  $PK$ ; I say, the

Angle  $M$ , or the Point wherein  $KM$  intersects  $PM$  will be the Curve requir'd.

For  $AC$  being  $= z$ , if  $AP = x$ , and  $PM = y$ , then by the Property of the Curve,  $AK$  or  $PM = y$  is  $= \frac{a^4 + 2 a a z z + z^4}{4 a a z}$ , and conse-

quently,  $\dot{y} = \frac{1}{2} \dot{z} + \frac{3 z z \dot{z}}{4 a a} - \frac{a a \dot{z}}{4 z z}$ ; and because  $BC$  is parallel to the Tangent in  $M$ , therefore the Triangle  $ABC$  is Similar to the little Triangle at  $M$ , and consequently  $a : z :: \dot{y} : \frac{z y}{a} =$

$\dot{x} = \frac{z z}{2 a} - \frac{3 z^3 \dot{z}}{4 a^3} + \frac{a \dot{z}}{4 z}$ , and the flowing Quan-

tity or  $AP(x)$  is  $= \frac{z z}{4 a} + \frac{3 z^4}{16 a^3} - S \frac{a \dot{z}}{4 z}$ ; but

by the Property of the Logarithmetical Line  $z : \frac{1}{4} a :: (R n) : \frac{a \dot{z}}{4 z} = RN$ , whence  $S \frac{a \dot{z}}{4 z} =$

$CN$ ; therefore  $AP(x)$  is  $= \frac{z z}{4 a} + \frac{3 z^4}{16 a^3} - CN$

$\pm$  an Invariable Quantity  $\frac{S a}{48}$ , and consequently,

when  $CN$  vanishes, then  $AP$  or  $x$  will vanish also, therefore  $CM$  is the Curve requir'd.

**SOLLICITOR**, is a Man employ'd to take care of, and follow Suits depending in Courts of Law, or Equity, formerly allow'd only to Nobility, whose Menial Servants they were; but now too frequently used by others, to the Damage of the People, and the Increase of Champerty and Maintenance.

**SOLSTICE**, is the Time when the *Sun* entring the Tropical Points, is got furthest from the Equator; and before he returns back towards it, seems to be for some time at a Stand, being moved in the same Parallel, and scarce making any other Lines than perfect Circles, so small is its Progress. These *Solstices* are two:

*Estival*, or Summer *Solstice*, when the *Sun* enters Cancer, the 11th of June, making the longest Day, and the shortest Night.

And the *Hyemal*, or Winter *Solstice*, on the 11th of December, when he enters Capricorn, the Nights being then at the longest, and Days at the shortest; that is, in Northern Regions; for under the Equator there is no Variation, but a continual Equinox; and in the Southern Parts, the Sun's Entrance into Capricorn, makes the longest Day, and into Cancer, the longest Night.

**SOLSTIAL Colure**. See *Colure*.

**SOLSTITIAL Points**, in *Astronomy*, are those Points of the Ecliptick, wherein the Ascent of the Sun above the Horizon, and his Descent below it are terminated.

**SOLUBLE Tartar**, is made by boiling in three Pints of Water eight Ounces of Cream of Tartar, and four Ounces of the Fix'd Salt of Tartar, for about half an Hour in an earthen Pan unglazed; and then when 'tis cool, filtrating and evaporating it 'till 'tis dry; eleven Ounces and six Drams of Salt will remain at the Bottom. This is the *Soluble Tartar*. 'Tis accounted a very good Apperitive Medicine.

'Tis



'Tis called also a Vegetable Salt. Sometimes the Tincture of Mars is added in this Preparation, and then 'tis called *Soluble Tartar Chalybeate*.

An *Emetick Tartar*, is also made of this Soluble Tartar, and Liver of Antimony, which works as the common one.

**SOLVENDO** *esse*, a Term in Law, signifying that a Man hath wherewith to pay, or is a Person solvent.

**SOLVENT**, the same with *Dissolvent*, being any Corrosive Liquor, or *Menstruum*, that will dissolve Bodies.

**SOLUTIO Chymica**, is a resolving any Body into its Chymical Principles; which are, Spirit, Salt, Sulphur, Earth and Water.

**SOLUTIO continui**, is a Dissolution of the Unity, and Continuity of the Parts; as in Wounds, Ulcers, Fractures, &c.

**SOLUTION**, in *Mathematicks*, is the answering of any Question of the Resolution of any Problem.

**SOLUTION**, in *Physicks*, is the Reduction of a solid or firm Body, into a fluid State, by means of some *Menstruum*.

**SOLUTIONE feodi Militis Parliamenti**, and *Solutione feodi Burgensis Parliamenti*, are Writs whereby Knights of the Shire and Burgesses may recover their Allowance, if it be denied.

**SOLUTIVE**. See *Laxative*.



**SOMME**, in *Heraldry*, signifies in *French Blazonry*, Horned, or a Stag carrying his Horns, and when there are less than thirteen Branches in them, they tell the Number F. See the Figure.

**SOMMONS**. See *Summons*.

**SOMNIFEROUS**, or Sleeping Medicines, are such, which consisting of foetid sulphureous Parts, dissipate and extinguish the animal Spirits, and hinder their Increase, whence follows Sleep. *Blanchard*.

**SONATA**, in *Musick*, a Piece, or Composition of Musick, which is wholly executed by Instruments, and is the same to Instruments as Cantata is to Voices.

**SOPHISTICATED**, the same with counterfeited, debased, or adulterated; and is usually spoken of Wines, Chymical Preparations, &c. when they are not made good in their Kinds, through the Avarice of the Composer.

**SOPORIFEROUS**. See *Somniferous*.

**A SOPORIFICKS**, *Soporifica*, *Latin*, Medicines that have the Faculty of causing Sleep.

**SOPOROUS Diseases**, are the *Coma*, or *Catephora*, *Lethargy* and *Carus*, which seem to differ rather as to more or less, than as to Essence.

**SORITES**, is a Sort of Argument composed of several Propositions, of which the second depends upon the first, the third upon the second, and so forward.

**SORROW**, is an Uneasiness of the Mind, upon the Thought of a Good lost, which might have been enjoy'd longer; or the Sense of a present Evil.

**SOUND**, seems to be produced by the subtiler, and more ethereal Parts of the Air, being formed and modified into a great many small Masses or Contextures, exactly similar in Figure; which Contextures are made by the Collision and peculiar Mo-

tion of the Sonorous Body, and flying off from it, are diffused all around in the Medium, and there do affect the Organ of our Ear in one and the same manner.

*Sound*, also appears not to be produced in the Air, so much by the Swiftness, as by the very frequent Repercussions, and reciprocal Shakings of the Sonorous Body.

Sir *Isaac Newton* demonstrates (in *Prop. 43. Lib. 2. of his Principles*) that Sounds, because they arise from the tremulous Motion of Bodies, are nothing else but the Propagation of the Pulse of the Air. And this, he saith, is confirmed by those great Tremors that strong and grave Sounds excite in Bodies round about, as the ringing of Bells, Noise of Cannon, &c.

And in another Place he concludes, That Sounds do not consist in the Motion of any *Æther*, or finer Air, but in the Agitation of the whole common Air; because he found by Experiments, that the Motion of Sound depended on the Density of the whole Air.

He found by good Experiments, that a Sound moves 968 Feet, English, in a Second of Time, pag. 270.

Supposing the Air, by the Pulse which causes Sound, to be in a Motion, like that of the Water when its Waves rowl; he calculates the Breadth of the Pulse, or the Distance between Wave and Wave, to be in the Sounds of all open Pipes, double the Length of those Pipes, which he grounds on an Experiment of *Father Mersennus*, in his *Harmonicks*, that an extended String made 104 Vibrations in a Second, when it was an Unisone with the *C fau ut* Pipe of an Organ, whose Length was four Foot open, and two Foot stopp'd, pag. 372.

Why the Sound ceases always with the Motion of the Sonorous Body; and why they reach the Ear equally soon, when far off or near, he shews in *Prop. 48, Cor.* where he proves, that the Number of the Pulses propagated is always the very same with the Number of the Vibrations of the Tremulous Body, and that they are not by any means multiplied as they go from it.

*The following Properties have been observ'd of Sound, in many of which there is a near Relation between it and Light. For,*

1. As Light acquaints the Eye with the different Qualities, Magnitudes, and Figures of Bodies; so Sound, in like manner, informs the Ear of many of the same Things in the Sonorous Body.

2. As Light presently vanishes on the Removal, or total Eclipse of the radiating Body, so a Sound perishes as soon as the Undulation of the Air ceases, which Motion both produceth and preserveth all Sounds.

3. The Diffusion of Sound from the Sonorous Body is *Spherical*, like the Radiation of Light from its Centre.

4. A great Sound drowns a less, as a greater Light eclipses a less.

5. Too great, loud, or shrill a Sound is offensive and injurious to the Ear, as too great and bright a Light is to the Eye.

6. Sound



6. Sound also, like Light, moves sensibly from Place to Place, tho' nothing near so swift as Light. It is reflected like Light from all hard Bodies; it is hindred and refracted, by passing through a denser Medium. But it differs from Light in this, that whereas Light is always propagated in Right Lines, the Motion of Sound is always *Curvilinear*.

7. Sound also differs much from Light in this, that it is very much weakned by Winds, and such like Motions of the Air, which yet have no Effect on Light. For *Mersennus* computes, that the Diameter of the Sphere of a Sound heard against the Wind is near a third Part less than when coming with the Wind.

8. A very small Quantity of Body serves to reflect the Rays of Light, as we see manifestly in small Pieces of Looking-glasses, &c. But there appears to be necessary a Body of much larger Dimensions to return a Sound, or to make an Echo.

9. As to Reflection of Sounds, 'tis observed, that if one stand near the reflecting Body, and the Sound be not very far off, tho' an Echo be produc'd, yet it cannot be heard, because the direct and reflex Sound enter the Ear almost at the same time: But then the Sound appears to be stronger than ordinary, and lasts longer; especially when the Reflexion is made from diverse Bodies at once, as from Arches and Vaulted Rooms, from whence the confused Bomb of such like Places arises.

And from hence probably may be deduced the Reason why concave Bodies are (*cæteris paribus*) fittest to produce great and clear Sounds; such as Bells, &c. for in such Bodies the Sound is very swiftly and very often reflected from Side to Side, and from one Part of the Cavity to another, and the Bell hanging at liberty, this produces great Tremblings and Shakings of the whole Concave Body, which occasions the Sound to continue 'till they cease and are quiet.

10. There is one Phænomenon of Sounds that is indeed very wonderful, that all Sounds great or small, with the Wind or against it, from the same Distance, come to the Ear at the same time.

Dr. *Holder* in his Books of the Natural Grounds and Principles of Harmony, says, that if the tremulous Motion which causeth Sound, be uniform, then it produces a musical Note, or Sound: But if it be difform, then it produces a Noise.

The *Florentine* Academicks found a Sound to move one of their Miles (*viz.* 3000 *Braccia*, or 5925 Feet) in five Seconds of Time: Therefore, according to them, it moves 1185 Feet in one Second.

But Sir *Isaac Newton* found it to move but 968 Feet in a Second of Time.

**SOUND.** Mr. *Carre*, of the Royal Academy of Sciences at *Paris*, hath published a Book, *Sur la Theorie General du Son*, &c. In which he shews that Sound, when consider'd with relation to Body, consists only in the Motion of the Air; but in such a Motion as is very different from the

Wind. The first Motion from whence Sound comes, is produced (he thinks) by little Vibrations, or Shakings repeated, which the Parts of the Sonorous Body occasions in the Air; whereas Wind consists in a local Motion of the Air, without Vibrations; and this he proves by several Experiments. The Motion of the Air in Winds, will act strongly on Flame, but will not affect the Ear with Sound, but on the Interposition of some Body, which may occasion some Vibrations: Whereas the Agitation of the Air in Sounds affects not Flame; for a lighted Candle put near a Bell which hath been struck, will not have its Flame agitated by the Sound.

He concludes also, that Sound is not produced by a total and sensible Vibration of the sonorous Body; but by insensible Vibrations of the little Parts, always helped, and sometimes occasioned by total Vibrations. Thus, when a Cord hangs loose, it will move forward and backward quick enough (when struck) without making any Sound; because through want of being straightly extended, each little Part can't make its Vibrations by itself, and communicate them to the Air.

In sonorous Bodies, in the same, or of different Matter, the Difference of Sound, as to *Grave* or *Acute*, flows from the greater or lesser Spring of each Part, and from the more or less Quickness with which these Parts do bend and unbend. Two Strings, or Wires, one of Gold, and the other of Steel, of the same Length, Thickness and Tension, yet will give a different Sound, *viz.* the Gold one more *Grave*, the Steel-wire one more *Acute*; because the Parts of the Gold are more soft and flexible, and have less Spring than those of the Iron, and therefore will have less speedy and weaker Vibrations. But yet Sound, be it flat or sharp, is still strong or weak; and 'tis not the Strength or Weakness of Sound, that renders it flat or sharp: Strong Sound arises from great Vibrations in the Air, and from a great Quantity of it, moved in the same time; and the weak Sound is occasioned by the just contrary. So that the Strength or Weakness of Sound, is in Proportion to the Quantity of Air struck, and the Strength of the Vibrations: But *Grave* and *Acute* Sounds follow the Proportion of greater or lesser Number of the Vibrations of the Air in the same time.

The Reverend Dr. *William Derham*, a very industrious and useful Member of the *Royal Society*, in *Philosophical Transactions*, Numb. 313, hath obliged the World with some very curious and careful Observations and Experiments about the Motion of Sound; being furnished with very good Instruments, and many Advantages to make them, which others have not been.

He observes, first, that there hath been a considerable Difference in the Accounts given by good Authors, about the Velocity of the Motion of Sound. Sir *Isaac Newton*, in *Princip. Lib. 2. Prop. 50*, allows but 968 Feet for the Progress of Sound in a Second of Time.

The Hon. Mr. *Fr. Roberts*, *Phil. Trans.* N° 207, 1300 Feet.

Mr. *Boyle*, in his *Essay on Languid and Unheeded Motion*, 1200 Feet.

Dr. *Walker*, in *Philosoph. Transact.* Numb. 247, 1338 Feet.

*Mersennus* in *Balistic. Prop. 39.* 1474 Feet.

*Flamsteed* and *Halley*, 1142 Feet.

6 S The



The *Florentine Academy*, 1148 Feet.

The *French Observ. Hist. Acad. Regiæ*, 1172 Feet.

The Reason of this Diversity he judges to arise, (1.) From these Gentlemen not using good Pendulum Clocks ordinarily, but a String and Plummet only, of such a Length as to swing Seconds. But this latter way cannot be so exact as that by a Movement; because the Observer's Eye must first observe the Flash of the Gun, &c. fired; and then the Swing of the Pendulum, which takes up Time, and occasions much Confusion. (2.) From there not being *Distance* enough between the Sound and the Place of Observation. And, (3.) From there being no Regard had to the *Winds*, of which more below. And he judges, that the little Difference there is between the three last Numbers of 1142, 1148, and 1172, arises from there being good Pendulum Clocks made use of in these Observations, and the Distances being considerable.

After this, he proposes to answer the following Questions:

1. How far a Sound moves in a Second of Time, and consequently in any Time assigned?
2. Whether the Report of a Gun, discharged with its Mouth *towards*, comes *sooner*, than when its *Muzzle* is *from* the Observer?
3. Whether Sounds move in the same Time, the same Spaces, in all States of the Atmosphere, and Heights of the Barometer?
4. Whether they move faster by *Day*, or by *Night*?
5. Whether they move swifter with, or slower against the *Wind*? And how the *Wind* affects them?
6. Whether Sounds move faster in calm or still, than in windy and turbulent Weather?
7. Whether a strong transverse *Wind* accelerates or retards the Motion of Sound?
8. Whether Sounds have the same Degree of Velocity in Summer and in Winter?
9. Whether they have the same in snowy and clear Weather?
10. Whether a great Sound and a small one have the same Velocity?
11. Whether the Sound of a Gun move equally swift at all the Elevations of the Gun?
12. Whether different Strengths of Gun-powder change the Motion of the Sound of the Report?
13. Whether the Velocity be the same in all Heights of the Atmosphere above the Earth?
14. Whether the Report be in the same Time, if the Piece be discharged in an *Acclive* or *Declive* Position?
15. Whether all kinds of Sounds, as of Guns, Bells, Beetles, &c. have the same Velocity?
16. Whether Sound be swiftest in the beginning of their Motion, and slowest in the end?
17. Or whether they be not rather *equable*, moving equal Spaces in equal Times?
18. Whether Sounds move equally swift in all Regions? in *North*, *South*, &c. Climates?
19. Whether Sound move in a right Line the nearest way, or whether along the Earth's Surface?

To solve these Problems, Dr. Derham was at the Trouble of getting, and had the Advantage of

hearing and seeing from the Tower of his Parish-Church at *Upminster* in *Essex*, many Muskets fired at the Distance of one, two, three, and so far as to eight Miles; beyond which he could not hear, in that woody Place, the Report of a Musket. But though the firing of these Small Arms did him much Service in his Design, he was much better served by the Ordnance, or Great Guns, on *Black-Heath*; for he could from his Church aforesaid, always by Night with his naked Eye, and by Day with a Telescope, see the Flashes of the *Sakers* (a sort of Cannon) there fired, to exercise her Majesty's young Engineers, and hear their Report very plainly. On these he made many repeated Observations; and at last, by favour of the Board of Ordnance, he got leave to have two *Sakers* (see that Word before) to be placed one by another on the *Heath*, but with their Muzzles quite contrary ways; and on the 13th of *February*, 1704, to be discharged continually every half Hour, from six in the Evening 'till twelve at Night: There was a small Gale of Wind blowing directly against the Sound.

The Interval between the Flash and the Report of each Gun, he always found to be about 120 or 122 half Seconds of Time. He mentions both these Numbers, because the Sound of the Report always came double; the first within 120 half Seconds; the second (which he takes to be an Echo from the Wind-Mill, or adjacent Houses on *Black-Heath*) within 122.

He observed no Difference in the Time of the Sound's Progress, when the *Saker* was fired *towards* him, or *from* him, which answers his second Question.

Nor did he find that any *different Elevation* of the several Muzzles made any Alteration in the Motion of the Sound; which is an Answer to his 11th *Problem*. And to solve the 12th *Query*, he found that different *Quantities* or *Strengths* of Powder, made no Alteration in the *Velocity* of the Sound's Motion, tho' it manifestly did so in the *Strength* of the Noise. Nor did he find that there was any Variety in the Time of the Motion of the Sound, either by Night or Day; whether it were clear or cloudy; whether it rained or snowed, whether the Barometer were high or low, and whether it were Summer or Winter; which solves his 3, 4, 6, 8, 9 *Queries*. He found also, in answer to his 15th Question, that all kinds of Sounds, as of Bells, Beetles, Muskets, &c. from the same Distance came to his Ear in the same Time.

And the same he found as to intense or strong, and languid or weak Sounds; which answers his 10th Question.

By repeated and very accurate Observations, he also found the Motion and Time of the Progression of Sound to be in all respects *equable*; which solves the 17th *Problem*; that is, that Sound moves just an *English* Mile in  $9\frac{1}{4}$ , or 9, 25 half Seconds; two Miles in  $18\frac{1}{2}$ , three Miles in  $27\frac{1}{4}$ , &c. and so on uniformly.

As to his last, or 19th Question, he is confirmed, that Sound moves the nearest way, and that it doth not creep along the Earth's curved Surface: And he believes (in Answer to the 14th *Query*) that the Velocity of the Sound is the same in *Acclivities* and *Declivities*; tho' he hath not had Opportunity of making Experiments enough to determine it exactly.

From



From the Communications which his Friends in *Italy* have afforded him, he thinks the Difference of Regions or Climates, makes no Difference in the Motion of Sounds; which is an Answer to his 18th Question.

He found that very thick, cloudy and snowy Weather, did always lessen and dull the Noise made by the Discharge of Guns, &c. whereas in frosty and clear Weather, they were much more audible, clear, and distinct than at any other times.

By many repeated, and accurately made Experiments, he discovered, that contrary Winds do always retard the Motion of Sounds, and that in Proportion to their Strength; which is what the *Florentine Virtuosi*, and many others, have formerly been entirely mistaken in; asserting, that Contrariety of Winds occasions no Retardation of the Motion of Sound.

By Observations and Experiments made with proper Instruments, about the Velocity of the Motion of Wind, he concludes, that in the greatest and most rapid Storms that ever blew, the Wind moves not above 60 Miles an Hour, and perhaps not above 50; whereas Sounds may go above 700 Miles in the same time; and consequently they cannot be the same Particles of the Air, or Atmosphere, which carry both; at least they cannot be moved after the same manner. He concludes, as above said, that the Velocity of Sound is such, that it ordinarily moves 5280 Feet, or an *English* Mile, in  $9\frac{1}{4}$  half Seconds: And that it moves 571 in a half, and 1142 Feet in a whole Second of Time. But that the Winds may so affect it, by conspiring with its Motion, as to carry it 600 Feet in half a Second; or, by being contrary to it, to retard it so, that it may not move more than 560 Feet in a half Second of Time.

He concludes with shewing the Uses that may be made of this Knowledge of the Velocity of the Motion of Sound, in measuring the Distances of Ships at Sea from one another, or of a Ship from Shore; of Forts and Batteries one from another, or of any Places at Land within the hearing of the Report of a Gun; of the Distances of Thunder, Clouds, &c.

In *Philosophical Transactions*, Numb. 156, you have an Account of the Doctrine of Sounds, by *Narcissus*, Bishop of *Ferns* and *Leighlin*; and in Numb. 247, of the Swiftneſs of Sounds, and their Reflections by Echoes.

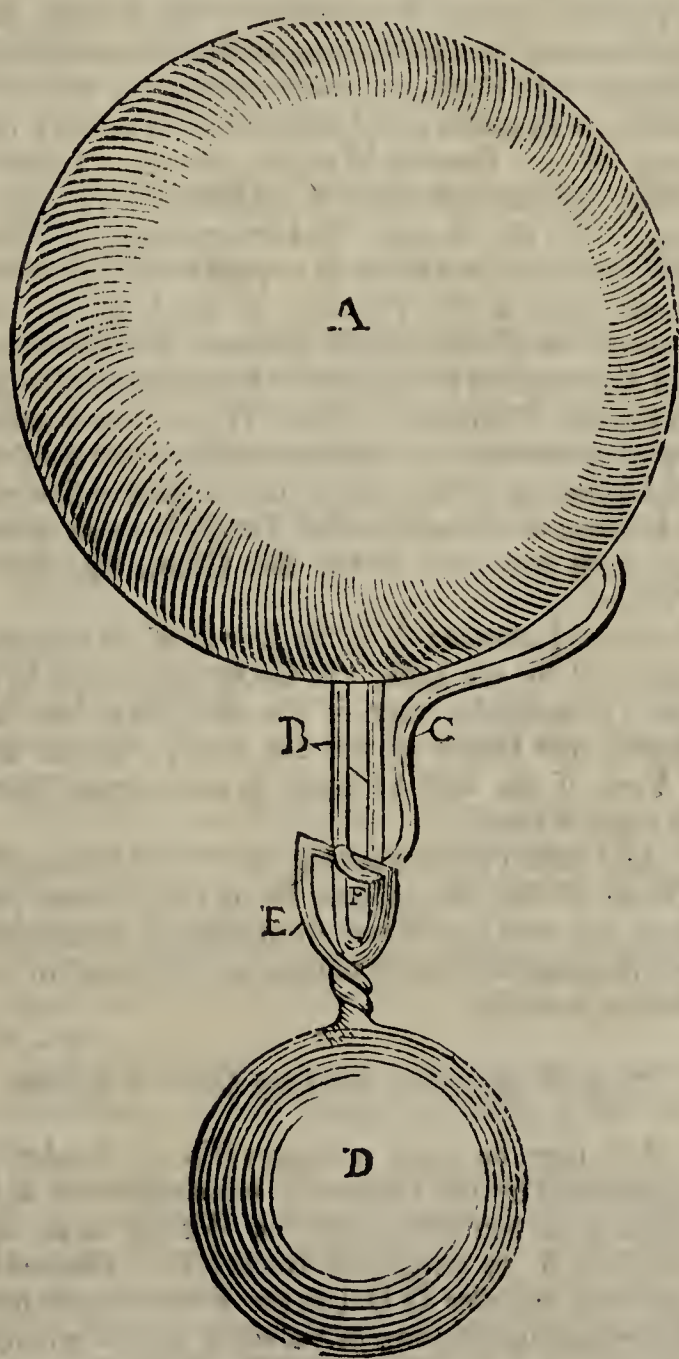
In the History of the Royal *French* Academy for *A. D.* 1700, they say it hath been experienced, that a Sound moves 180 of their Toises in a Second, or 283 middle *French* Leagues in an Hour. (1.) Therefore they conclude, that the Air must be moved or struck at first with a very great Smartneſs or Swiftneſs. (2.) All Conjectures and Physical Reasons persuade us, that this Motion or Stroke on the Air, must be impressed by very brisk Vibrations of the small Parts of the Sonorous Body, in order that they may exert their Spring, or elastick Force. (3.) In *Philosophical Transactions*, Numb. 297, you have an Account of some Experiments of Mr. *Hawksbee's*, whereby it appears plainly, that as exhausting the common Air out of a Receiver doth very much lessen the Noise made by the Bell there hung and struck, so crowding or conveying more Air into a Vessel made on purpose for such Condensations of Air, did very sensibly augment the Sound of the included Bell.

SOUND, in *Geography*, is any great Indraught of the Sea, between two Head-lands, where there is no Passage through.

SOUNDING, when the Seamen try the Depth of the Water with a Line and Plummet, they call it Sounding. But their *Sounding Line*, as they call it, is a Line different from the *Deep Sea-Line*, as being bigger than it, and not much above twenty Fathom in Length; and is marked at two Fathom, with a Piece of black Leather betwixt the Strands; so also at three Fathom, and at four; but at five it is marked with a Piece of white Leather, or Cloth.

This Line can be used when the Ship is under Sail; but the *Deep Sea-Line* cannot be used well, except the Ship be brought upon the Back-Stays. (See *Deep Sea-Line*.)

To sound the deepest Sea without a Line.



Take a Globe of Fir, or Maple, or other light Wood, as A; let it be well secured by Varnish, Pitch, or otherwise, from imbibing Water; take also a Piece of Lead or Stone D, considerable heavier than will sink the Globe.

Let there be a long Wire-staple B, in the Ball A, and a springing Wire C, with a bended End F; and into the said Staple press in, with your Fingers, the springing Wire on the bended End: And on it hang the Weight D by its Hook E; and so let the Globe and all sink into the Water gently, in the Posture represented in the said Figure, to the Bottom,



tom, where the Weight D, touching first, is thereby stopp'd; but the Ball being by the *Impetus* it acquired in descending, carried downwards, a little after the Weight is stopp'd, suffers the springing Wire to fly back, and thereby sets itself at Liberty to re-ascend: And by observing the Time of the Balls stay under Water (which may be done by a Watch, having Minutes and Seconds; or by a good Minute-glass; or best of all by a Pendulum vibrating Seconds, which must be 3 Foot  $3\frac{1}{2}$  Inches long, *viz.* between the middle of the Bullet, and the upper End of the Thread, where it is fastened, or held when it vibrates. By this way, with the Help of some Tables, you may come to know any Depth of the Sea.

*Note,* That Care must be had of proportioning the Weight and Shape of the Lead, to the Bulk, Weight, and Figure of the Globe, after such a manner, as upon Experience shall be found most convenient.

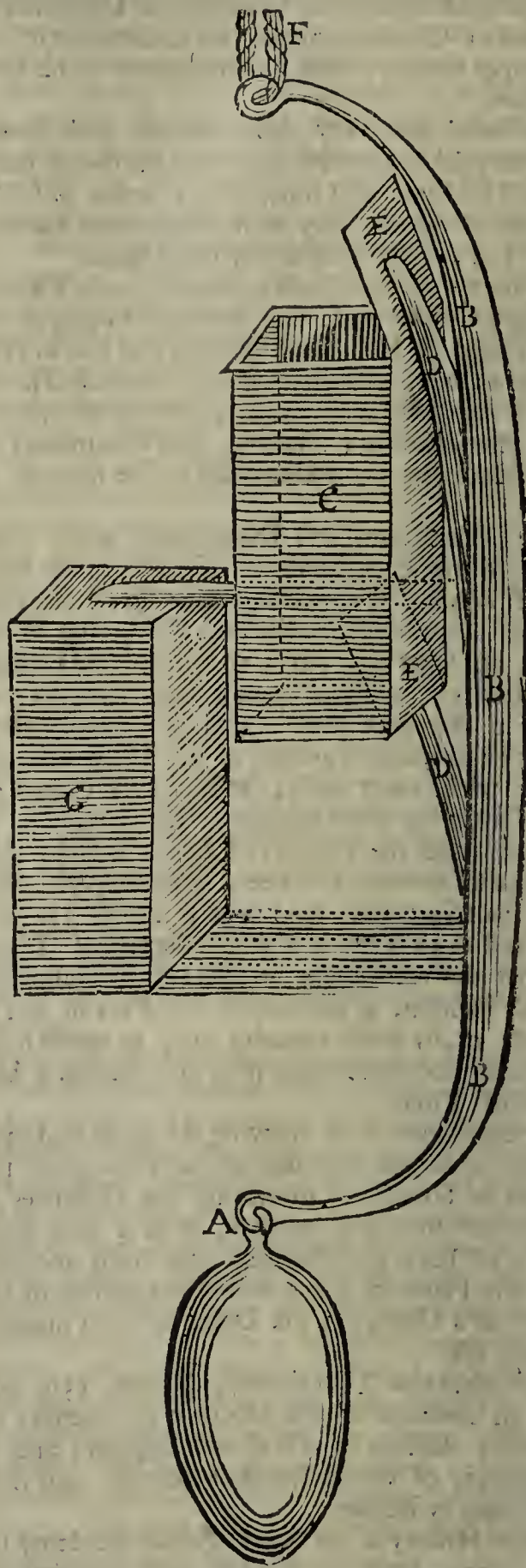
In some of the Trials already made with this Instrument, the Globe being of Maple-wood, well covered with Pitch, to hinder soaking in, was  $5\frac{1}{2}$  Inches in Diameter, and weighed  $2\frac{1}{2}$  Pounds; the Lead of  $4\frac{1}{2}$  Pounds Weight, was of a Conical Form (but is now used of a Globous) 11 Inches long, with the sharper End downwards,  $1\frac{1}{2}$  at the Bottom, in Diameter: And in those Experiments made in the *Thames*, in the Depth of 19 Foot Water, there passed between the Immersion and Emerision of the Globe, 6 Seconds of an Hour; and in the Depth of 10 Foot Water, there passed  $3\frac{1}{2}$  or thereabout: From many of which kind of Experiments, it will likely not be hard to find out a Method to calculate what Depth is to be included from any time of the like Globes stay under Water.

As for Instance: If in the Depth of 20 Fathom, measured by the Line, the Globe stays under Water 15 Seconds, then if the Ball stay 700 Seconds, the Depth of the Sea is 933 Fathom and 2 Feet, if the Ball be found to move equal Spaces in equal Times.

And now I'm mentioning the way of finding the Depth of the Sea, it may be of use to shew you how you may get Water from thence, which shall not communicate as it comes up with any of the Water above it.

*To fetch up Water from any Depth of the Sea.*

Let there be made a *Square Wooden Bucket*, as represented by the Figure C, whose Bottom E E, are to be so contrived, that the Weight A do sink the Iron B, to which the Bucket C is fastened by the two Handles D D (on the Ends of which are the moveable Bottoms or Valves E E) and whereby draws down the Bucket: The Resistance of the Water keeps up the Bucket in the Posture C, whereby the Water hath a clear thorough Passage all the time it is descending; whereas, as soon as the Bucket is pulled upwards by the Line F, the Resistance of the Water to that Motion, beats the Bucket downwards, and keeps it in the Posture G; whereby the included Water is preserved from going out, and the ambient Water kept from going in.



By the Advantage of this, or the like Vessel, the several *Degrees of Saltness* of Sea-water may be known according to its Nearness to the Top or Bottom; or rather the Constitution of the Sea-water in the several Depths of several Climates.

SOUNDS, in *Musick*, are distinguished into *Simple* and *Compound*; and that two ways.

In the first a *Sound* is said to be *Compound*, when a Number of successive Vibrations of the Sonorous Body and the Air come so fast upon the Ear, that they are judg'd to be the same continued *Sound*.

A *Simple Sound* then with respect to this Composition, should be the Effect of a single Vibration, or of so many Vibrations as are necessary to raise the Idea of Sound in us.

SOUND-Board of an Organ, is the principal Part of that Instrument, and that which causes the



the whole Machine to play. It is a Reservoir by which the Wind that is drawn in by the Bellows is conducted by a Port-vent, and by it distributed into the Pipes which are placed over the Holes of its upper Part. This Wind enters them by Valves, which open by pressing upon the Stops or Keys, after drawing the Registers, which prevent the Air from going into any of the other Pipes, but those it is required in.

**SOVEREIGN**, was a Piece of Gold-Coin, current at Twenty-two Shillings and Six-pence, in 1 Hen. 8. when, by Indenture of the Mint, a Pound Weight of Gold of the old Standard was to be coined into Twenty-four *Sovereigns*. In 34 Hen. 8. *Sovereigns* were coined at Twenty Shillings, and half *Sovereigns* at Ten Shillings. In 4 Edw. 6. *Sovereigns* were coined at Twenty-four Shillings a-piece, in 6 Edw. 6. at Thirty Shillings; and also in 2 Eliz.



**SOUTENU**, in *Heraldry*, is as it were supported by a small Part of the Escutcheon, beneath it, of a different Colour or Metal from the Chief, and reaching as the Chief does from Side to Side, being, as it were, a small Part of the Chief of another Colour, and supporting the Chief, as in the Escutcheon.

**SOUTH Direct Dials**. See *Prime Verticals*.

**SOUTHERN Signs**. See *Austral Signs*.

**SOWNE**, is a Term of Art used in the *Exchequer*, and seems a Corruption from the *French Souvenu*, i. e. *remembred*: For the Stat. 4 Hen. 5. c. 7. in the Original *French*, hath *Des Estreats oriens Souvenu*. And such *Estreats* and *Casualties* as are not to be remembred, run not in Demand, i. e. are not leviabie. So now in the *Exchequer*, they say, such *Estreats* as the Sheriff, by his Industry, cannot get, are *Estreats that Sowne not*; and *Estreats that Sowne*, are such as he may gather.

**SPACE**, in *Geometry*, is the Area of any Figure, or that which fills the Intervals or Distance between the Lines which terminate it.

**SPACE**, if consider'd barely in Length, between any two Beings, is the same Idea that we have of *Distance*; but if it be consider'd in Length, Breadth and Thickness, it is properly called *Capacity*; and when consider'd between the Extremities of Matter, which fills the Capacity of *Space*, with something Solid, Tangible and Moveable, or with Body, it is then called *Extension*; so that *Extension* is an Idea belonging to the Body only; but *Space*, 'tis plain, may be consider'd without it. So that *Space*, in the general Signification, is the same thing with *Distance*, consider'd every way, whether there be any solid Matter in it or not.

*Space* therefore is either *Absolute* or *Relative*.

*Absolute Space*, consider'd in its own Nature, and without regard to any thing external, always remains the same, and is immoveable; but *Relative Space* is that moveable Dimension, or Measure of the former, which our Senses define by its Positions to Bodies within; and this the Vulgar use for immoveable *Space*.

*Relative Space*, in Magnitude and Figure, is always the same with *Absolute*; but 'tis not necessary it should be so Numerically. Thus if you suppose a Ship to be indeed in absolute Rest, then the Places of all things within her, will be the same Abso-

lutely and Relatively, and nothing will change its Place. But then suppose the Ship under Sail, or in Motion, and she will continually pass through new Parts of Absolute Space: But all things on Board consider'd Relatively, in respect to the Ship, may be notwithstanding in the same Places, or have the same Situation and Position, in regard to one another.

**SPHÆNOPHARYNGÆUS**, in *Anatomy*, a Pair of Muscles, called also *Pteryropharyngæus*, &c.

**SPAGYRICA Medicina**. See *Hermetick*.

**SPAGYRICK**, or *Spagyric* Art, the same with Chymistry; and a *Spagyrist*, is a Chymist. Chymistry is called the *Spagyric* Art, from *σπάω* and *ἀγύρεω*, to extract, and to collect, or gather together. Because it teaches how to separate and extract the purer Parts, or Substances, from mix'd Bodies.

**SPARADRAPUM**, is a Piece of Linen tinged on both Sides, either with a thick Ointment, or Plaister, and is made this way. After you have melted your Ointment, or Plaister, dip your Linen in it, extend it, and keep it for use. *Blanchard*.

**SPASMODICKS**, are Medicines against Convulsions.

**SPASMOLOGIA**, is a Treatise of Convulsions.

**SPASMUS**, is any Convulsive Motion: *Cardan* makes two sorts of Convulsive Affections, viz. *Tetanus Spasmus*; and by the former he understands a constant Contraction, whereby the Member becomes rigid and inflexible; by the latter he understands sudden Concussions and Motions, which cease and return alternately. *Blanchard*.

**SPASMUS Cynicus**, a sort of Convulsions, whereby the Mouth is distorted on one side through the Contraction of the Muscles.

**SPECIALITY**, in *Law*, is most commonly taken for a Bond, or Bill, or such like Instrument.

**SPECIES**, in *Metaphysics*, or *Logick*, is an *Idea*, that relates to another more general one, to which it is subservient, and has only under it *Individuals* and *Singulars*.

*Impressed SPECIES*, in *Opticks*, are those that come from without, or are sent from the Object to the Organ.

*Expressed SPECIES*, are those, on the contrary, from within, or sent from the Organ to the Object.

**SPECIES**, in *Algebra*, are those Letters, Notes, Marks, or Symbols, which represent the Quantities in any Equation or Demonstration. This short and advantageous way of Notation, was first introduced by *Vieta*, about the Year 1590, and by it he made many Discoveries in the Process of *Algebra*, not before taken notice of.

The Reason why *Vieta* gave this Name of *Species* to the Letters of the Alphabet subservient to *Algebra*, and why he calls it *Arithmetica Speciosa*, seems to have been in Imitation of the *Civilians*, who call Cases in Law, but abstractedly between *John a-Nokes* and *John a-Stiles*, or between *A*, *B* and *C*, supposing those Letters to stand for any Persons indefinitely; such Cases, I say, they call *Species*. Wherefore, since the Letters of the Alphabet will also as well represent Quantities as Persons, and that too indefinitely one Quantity as well as another, they may properly enough be called *Species*; that is, Symbols, Marks, or Characters.



raeters. From whence the *Literal Algebra* is frequently now a-days called *Specious Arithmetick*, or *Algebra in Species*.

**SPECIES**, in *Medicine*, are properly the Simple Ingredients in the Druggists, or Apothecaries Shops, out of which Compound Medicines are made: But the Writers of *Pharmacy* do usually give this Name to some *Aromatick* or *Cathartick Powders*, because, probably, they were formerly kept ready prepared in the Shops to form Electuaries, Tablets, Pills, &c. as some are still.

**SPECIES Visibles**, are those wonderfully fine superficial Images of the Bodies which the Light produces, and delineates in their due Proportion and Colours in the Bottom of our Eyes. These the *Aristotelians* would have to be immaterial; but a thousand Experiments prove, that though they are admirable subtle, yet they are really corporeal.

**SPECIFICK** is, in general, whatever is peculiar to any distinct Species of Things, and which distinguishes them from all others of different Species. Therefore the *Logicians* say, that in every good Definition of any thing, the Specifick Difference ought always to be inserted. Hence,

**SPECIFICK**, in *Medicine*, is a Remedy whose Vertue and Effect is peculiarly adapted to some certain Disease; is adequate to it, and exerts its whole Force immediately on it.

**SPECIFICK Gravity**, is the appropriate and peculiar Gravity or Weight, which any Species of Natural Bodies have, and by which they are plainly distinguishable from all other Bodies of different kinds. By some 'tis not improperly called *Relative Gravity*, to distinguish it from *Absolute Gravity*, which encreases in Proportion to the Bigness of the Body weighed. Thus, if any Body weigh a Pound, one as big again will weigh two Pounds: And let the Bodies be of what Nature or Degree of Specifick Gravity soever, a Pound of one will be as much as a Pound of the other, Absolutely consider'd: Thus, as is commonly said, a Pound of Feathers is as heavy as a Pound of Lead. But if you consider Lead and Feathers relatively, the Specifick Gravity of the former will be much greater than that of the latter: Or Lead, or Bulk for Bulk, will be much heavier than Feathers; and Gold heavier than Lead, &c.

'Tis of so great Advantage in many respects, as will appear below, to find truly the Specifick Gravities of Bodies, that many curious Ways have been thought of, and experimented for this Purpose: As by forming exact Cubes of different Substances, and taking their Weight accurately in nice Scales; and by melting Metals of different Gravities, and then casting them in Moulds of the same Dimensions. But for Practice and universal Use, nothing is better than the following Method, which is, to weigh any Body first in Air, and then in Water; which latter being considerably a denser Fluid than Air, will buoy up the Body immersed in it in part; and will consequently make it weigh less there than in the Air. And if after this you subtract the Weight found in the Water, from the former in the Air, a Remainder, or Difference, will be found, which is the Weight of as much Water as is equal to the Bulk of the Body. As *Archimedes* hath demonstrated Mathematically, and Mr. *Boyle* Physically and Experimentally, in his *Hydrostatical Paradoxes*. So that by this Means, having two Bodies, one Firm, and the other Liquid, with the Weight of each Part, 'tis very easy to

find the Proportion that one hath to the other, Bulk for Bulk; by only dividing the greater by the lesser; for the Quotient will shew the Specifick Gravity of the heavier Body compared with as much Water as is equal to it in Bulk. As if the Quotient be 2, 3, 6, or 19; the Body will accordingly be twice, thrice, six or nineteen times as heavy as common Water.

The Application of which Rule, and the great Advantages which may be made of the Use of it, you will find in the following Problems and Experiments.

I. To find the Specifick Gravity of such Bodies as will sink in Water, and not be dissolved by it.

Having ready a Pair of good small Scales, which will turn with the  $\frac{1}{8}$  of a Grain (or  $\frac{1}{4}$  Part may do well enough) drill a small Hole in the middle of one Scale, through which put a Horse-hair about a Foot in Length, with a Knot at the upper End of it, and a Loop at the other; put as much Horse-hair in the opposite Scale as will serve to equiponderate the other; and having well adjusted your Scales, weigh first the Body in the Air, carefully turn the Weight into Grains ('twill be best to use *Troy Weight*) and write down the Number on a Piece of Paper. Then fasten the Body to the Horse-hair, and leisurely immerse it into a Vessel of Rain, or Spring Water, and putting Weights into the opposite Scale, find its Weight exactly in the Water (where it must swim about freely, and not touch the Bottom or Sides of the Vessel). Turn also this Weight into Grains, and subtract it from the former Weight in Air, and note the Remainder; by which Remainder divide the first found Weight in Air, and the Quotient will be the Proportion that the Body bears to Water; that is, will shew the Specifick Gravity in respect of Water, which is pitched on as a Standard to compare it by.

#### E X A M P L E.

A Piece of white Marble weighed in Air 1169 Grains, and in Water 738 Grains; which subtracted from the former Weight, left 431 Grains; by which Remainder dividing the Weight in Air 1169, the Quotient was  $2\frac{71}{80}$ , which is the Specifick Gravity of Marble, in respect of as much Water as is equal to it in Bulk.

N. B. If you practise this much, 'twill be best to hang your Scales upon a Gibbet, or some other Rest, where they may hang freely; and so you may have both your Hands at Liberty for more nicely adjusting the Balance, and your Arm will not be weary with holding the Scale; and be sure that the Scales play freely, and are no way tangled, and that you do not wet your Weights, nor Scales; for a little Carelessness may produce great Errors in such Cases: Let also the Body hang a while in the Water before you weigh it, and move it up and down, and gently knock it against the Sides of the Vessel, to extricate it from all Bubbles of Air, that, else sticking to it, may buoy it up a little, and consequently induce you to mistake its Weight. You should also have a small Pair of Pliers, or Tongs, to take up your Grains withal, lest you let them fall; which, with your Fingers, you may be apt to do, and so occasion your self a needless Trouble.

'Twill be convenient also to make a little Net of Horse-hair (of small Mashet) to hold round or small



small Bodies, that cannot conveniently be fastened with one Hair only; be sure always to equipoise your Scales before you begin to weigh.

*The Uses of this Experiment.*

1. Since common Stone, Marble, and Rock-Chrystal, &c. (See the Table of *Specifick Gravity*) are to Water but as  $2\frac{1}{2}$  (or 5 to 2;) if you find a Piece of strong Matter, whose *Specifick Gravity* exceeds that Proportion, you may conclude, that it hath in it something of a Mineral, or Metalline Nature, in Proportion to its Excess above the Weight of common Stone.

2. By this Method also a Body may be examined, whether it be of a stony Nature or not; so Coral and Pearls will be discovered to approach rather to a stony; than to a common Vegetable, or Animal Nature; and Bezoar, and the Stones found in the Bladders of Men, or other Animals, will, by their great Lightness, shew themselves of a very different Constitution from ordinary Stones.

3. By this Method you may make an Estimate of the Goodness of several Stones, or Bodies of the same Kind, or Denomination: For having found the Gravity of such as are excellent, all others of lesser Goodness may easily be distinguished, as they are any way diverse from that Standard.

4. And thus also Genuine Stones, or Minerals; may be easily distinguished from false ones; and counterfeit Money readily known from Sterling; tho' never so well washed over, or gilded; for having by your own Trials, or by the Help of such a Table as is here annexed, gotten the *Specifick Gravity* of such Stones, Gems, or Corns, as are true and genuine, let that be the Standard whereby to estimate others by; which last Use, is of universal Advantage, and may assist the Physician, Apothecary, or Druggist, in Drugs; the Jeweller in Gems, and Precious Stones, and the African Merchant in the Choice of the Sand, or Dust Gold, which is often counterfeit.

Had the Curious Dampier known this Method, he might perhaps have trucked and gotten some of the Indian yellow Rings at the *Bashee Island* (*Vid. Dampier's Travels, Edit. 2. Chap. 15, p. 427.*) which it appears he had no great Encouragement to do, not being able exactly to distinguish whether they were Gold or not.

II. To weigh Mercury, or such heavy Fluids that will sink into, and not mingle with Water; as also the Fragments of, or small Precious Stones, Pearls, &c. and all Powders that are heavier than Water, small Sands, Filings of Metals, Gold Grains, or Dust, and such like small things, about which a Horse-hair cannot be fastened.

Provide a small Glas Jar, or a little Silver or Brass Cup (but Glas is best when it can be had) with two Handles or Ears to it, and that shall hold about an Ounce and a half, or two Ounces of Water; and weighing it carefully in the Air first, note exactly its Weight (which lay by in some ready Place) then also find the Glas's Weight in Water, and lay the Weights carefully by by themselves; and if you intend to make frequent Use of this Practice, 'twill be better to get two Pieces of Lead, one of the Weight of the Glas in

the Air, the other of its Weight in Water, which will be always in readiness. This done, put the Mercury, Liquor, or Powder you intend to weigh into your Glas (which may be called the *Hydrostatical Bucket*) and putting into the opposite Scale the before-found Weight of the Bucket, find the Weight of the Matter in Air; and write it down (as in *Experiment 1.*) then take the Bucket out of the Scale, and pour into it, by degrees (that it may mingle well with it, and exclude all Air) Water enough to cover the Matter, or wet it thoroughly; and then putting into the opposite Scale the Weight that answers to the Bucket in Water, fasten your Bucket by a Horse-hair to your Scale, and let it down gently into a Vessel of Water, and so find its Weight carefully in the Water: then (as in *Experiment 1.*) subtract that from the Weight in Air, and by the Remainder divide the Weight in Air, and the Quotient will be the *Specifick Gravity* of the Liquor, Powder, &c. to as much Water as is equal to it in Bulk.

III. To weigh such solid Bodies as will dissolve in, or be injured in Water.

Weigh them (as before) first in Air, and then, instead of Water, use the clear Oil or Spirit of Turpentine, which is cheap enough, and may be had at any Druggists, in which no Salts, nor Vitriols, nor acid Sublimates will dissolve; and proceed in all things, as if you weighed the Body in Water; and so you will obtain the *Specifick Gravity* of the Body in respect of Oil of Turpentine; which may be the Rule for these Sorts of Bodies, as common Water was for the others. And this way will have the same Use as the other: For having at any time weighed a Piece of any Body (as suppose *Mercurius dulcis*) in the Oil, that you know is good; that may be your Standard to try more of the same Sublimate for the future; for if you find it hath not the same *Specifick Gravity* that the former (which you weighed) had, but is lighter, you may conclude it hath not its due Proportion of Mercury, and consequently is adulterated, as indeed that which is sold in the Druggists Shops often is; and therefore those that deal much in such things, may make a Table (from their own Experience) of the Weights of Bodies in respect of Oil of Turpentine, which will be of ready Use to them: And then their *Specifick Gravity*, in respect of Water (by a little Calculation) may be easily enough found by the following Experiment.

IV. To find the *Specifick Gravity* of Liquids and Fluids.

1. These are of two sorts, and consequently 'twill be expedient to be furnished with a double Standard to examine them by. In order therefore to find the Weight of Common Water, Beer, Ale, Burning Spirits, or any Vegetable or Animal Liquors; get either a Piece of Amber, or Red hard Sealing-Wax, or a Roll of common Brimstone, and weigh it first in the Air, and then in the Liquor you intend to examine; and (proceeding as in *Exper. 1.*) you will thence find the *Specifick Gravity* of that Body in respect of the Fluid, and consequently of the Fluid in respect of that Body: And therefore pitching on that Body as your common Standard, 'tis easy to compare the Weight of all Liquids of the first kind in Reference to it; for those in which the Body weighs



weighs *less*, will be the *heavier Liquors*: And those in which it weighs *more*, *lighter*, in proportion to the Decrease or Increase of the Weights of your Standard in the Fluid.

2. But to find the Weights of *strong, briny Sea-water, saline Menstrua*, and all *acid Spirits* and *Stygian-waters*, as the *Oil of Vitriol, Aqua-fortis*, &c. 'twill be necessary to employ a heavier Body for your Standard; and therefore in *such* weigh either a Piece of *Rock-Chrystal*, or, which will do as well, *white Marble*, or a Piece of *solid Glass*, such as the Tobacco-stoppers of that Metal, &c. which being more ponderous, will sink in these Liquors, in which *Amber* or *Wax* will not; and proceed as above in the former Part of this Experiment.

## U S E S.

1. By these Experiments, the Goodness of all kinds of Liquors may be examined: For, as to the first kind of Liquors before-mentioned, 'tis probable, the more fine and spirituous they are, the lighter they will be, and the more your Piece of *Amber* or *Sealing-wax* will weigh in them; which having once weighed in some Liquor of the kind, that you were assured was good, the Weight of your Piece in that, may be the Standard to compare others by. But the latter sort of Liquors will require a *contrary* way of *Estimation*; for the more ponderous they are, the better they may be judged to be; and consequently, the less your Piece of *Marble* or *Glass* weighs in them, the greater Degree of Goodness you may conclude them to contain. By weighing also the Solid in a Parcel of any kind of *these* that you have proved as good, its Weight may be the Standard, to compute the Goodness of those of the same Sort of Liquors.

2. Hence also you may most accurately discover, whether you are imposed upon by the *Merchant, Vintner, &c.* or *Distiller*, in Quantities of *Wine* or *Spirits* which you have bought on the Credit of the Sample that was shewed you to examine; for if you find that the Specifick Gravity of the whole Vessel sent you home, is different from that Parcel which you tried, you may be assured, that 'tis some way mix'd and adulterated.

3. The Chymist also may by this Means adjust his *Menstrua* for the dissolving of Mineral or Metallick Bodies to the best Advantage; by so tempering them (either by weakening their Strength, or increasing it) that they shall prove the most expedite Dissolvents: For many know very well, that a *Menstruum* may as well be too strong, as too weak: And therefore the Specifick Gravity of an *apt Menstruum* may perhaps be the best Guide to proportion another for the same Purpose.

V. *To find the solid Content of any small Body, tho' never so irregular (if it be heavier than Water) by weighing it in Water.*

Mr. Boyle, by many curious Trials, found that a Cubic Inch of Water is equal in Weight to about 256 Grains, or half an Ounce, and 16 Grains Troy; which Number of Grains is very happy for such Trials, because of its many aliquot Parts; and also, because every 32 Grains answers to just one Eighth of an Inch.

Suppose therefore you weigh a Body first in Air, and then in Water, and shall find it in the latter

Medium to lose of its Weight in Air just 256 Grains, or half an Ounce sixteen Grains; you may conclude that the solid Content of that Body is just one Cubick Inch; and if it lose but half, or one quarter, or one Eighth of that Number of Grains, the Content is half, one quarter, or one Eighth of a Cubick Inch. So, on the other side, if it lose more than 256 Grains, as two, three or four times that Weight, its solid Content will be accordingly two, three or four Cubick Inches. The like also is true of all other proportional Decrements of the Bodies Weight, in Comparison of 256, the Standard for one Cubick Inch.

The Reason of this Process is clear enough, if we consider that every Body weighed in Water loses there so much of its Weight as the Water amounts to, which is equal to that Body in Bulk; or in other Words, that it weighs less in Water than in Air, by the Weight of as much Water as is equal to the Body in Bulk, which is the Fundamental Theorem of all Hydrostaticks, and is Mathematically demonstrated by *Archimedes*, and Physically by Mr. Boyle, in his *Hydrostatical Paradoxes*.

And since also, as is before declared, a Cubick Inch of Water weighs exactly 256 Grains, what every Body loses in Water, just that Sum (of its former Weight in Air) must needs be in Solid Content equal to a Cubick Inch; for the Decrement of its Weight is equal to the Weight of so much Water as its Bulk takes up (by the universal Theorem) and that is found to be in Weight 256 Grains, which is exactly equal to one Cubick Inch; therefore the Content of that Body is just so much.

## U S E S.

This is more exact than any Mensuration can be for small Bodies; 'tis very expeditious, and may be of good Use (besides its Curiosity) in a great many Cases, as is obvious to any thinking Person.

VI. *To find the solid Content of a Body lighter than Water, by its Weight in that Medium.*

This Experiment will have two Cases.

1. When the Body to be measured will not be injured by the Contact of the Water, weigh the Body in Air; and then take a Piece of Lead, or some such heavy Metal, and of a known and even Weight (as suppose a Penny-weight, or half a Penny-weight, &c. to avoid Fractions) and capable of sinking your Body in Water. Weigh your Lead in Water, and subtract that Weight from its Weight in Air, and keep the Remainder as the Specifick Weight of your Piece of Lead in Water. This done, fasten your Lead with Horse-hair to the Body you intend to measure; and weighing the Aggregate also in Water, subtract this last Weight from that just now found in Air, and the Difference will be the Specifick Weight of the said Aggregate in Water; and lastly, subtract from it the Specifick Weight of the Lead alone in Water, and the Remainder is the Weight of the light Body you intend to measure, or to find the Solid Content of; which is easily done by the Process in the close of the fifth Experiment: For this last found Weight being divided by 256, or by its half, one quarter, &c. will accordingly give you the Body's



Solid Content, in entire, half, or quarters of Cubick Inches.

*Example.*

Because this last Process hath something of Difficulty in it (especially to a young *Hydrostatitian*) I will subjoin the following Example, which will serve not only to enlighten this, but many other Rules of this nature.

- Grains.
1. A Cube of Oak, which was made with great Exactness by a good Workman, weighed in Air 192½
  2. A Piece of Lead just half an Ounce (to make it sink) weighed 240
  3. The Lead in Water weighed 220  
Which subtracted from 240, the Lead's Weight in Air, left for its Specifick Weight in Water 20
  4. The Aggregate of the Wood and Lead's Weight in Air was 433½
  5. The Weight of the Aggregate in Water was 162
  6. Which subtracted from the Weight of the Aggregate in Air 433 and a half left 271½
  7. The Specifick Weight of the Lead in Water (*viz.* 20) being subtracted from which last Remainder I left for the Weight of the Cube in Water 251  
Which last Number wants but 4 Grains and a half of 256, the Stand before-mentioned, *viz.* of the Weight in Grains of a solid Inch of Water.

C A S E 2.

When there is Danger of injuring the *Body* by its either being dissolved by Water, or else admitting it too much into its Pores, you may use Oil of Turpentine instead of Water; only instead of the Standard 256 Grains for a Cubick Inch, you must use 221, for that Mr. Boyle found a Cubick Inch of that Oil to weigh; and therefore proceed altogether as in the last Case, only use Oil instead of Water, and divide the Weight of your Solid in Oil of Turpentine, by 221, and the Quotient will give the Contents of it in Cubick Inches or Parts of an Inch.

You may also in some Cases, having first found the Weight of the Body you would examine in Air, over-lay it carefully with a Coat of Bees-wax, to keep it from being injur'd by the Water, and having then found the Weight of the Bees-wax used to cover it (which is easily done by weighing the Body again when covered, and then from that Weight subtracting the Weight of the naked Body before found) sink it in Water with a Piece of Lead as before taught; and observing the Weight of the Aggregate, then proceed with the remaining Part of the Experiment, as in Case 1.

VII. To find the Weight of any Floating Body, though never so great, by knowing what Part of it is under Water.

Suppose a Ship should have under Water a Part of its Hull equal to 100000 Cubick Feet, I choose such a round Number to avoid Fractions,

(how to find the Content of the Part of a Ship that is under Water doth not belong to this Place, but it may be easily enough done by one versed in solid Mensuration). 'Tis found by Experience, that a Cubick Foot of Water weighs 76 Pound Troy; and *Archimedes* hath demonstrated, that as much Water as is equal in Bulk to the Part of the floating Body that is under Water, is in Weight equal to the whole floating Body. Therefore 'tis plain, that to solve this Problem, you need only multiply 100000 by 76 (which is 7600000) and the Product is the Weight of the whole Ship in Pounds Troy.

A T A B L E of the Specifick Gravity of Bodies in Proportion to Water, from Mr. Boyle, and my own Experiments.

|  | Proportion:   |
|--|---------------|
| Amber  | as 1, 04 to 1 |
| Agate  | as 2, 64 to 1 |
| Allom Stone  | as 2, 18 to 1 |
| Antimony (Hungarian)                                     | as 4, 07 to 1 |
| Antimony Crude, which seem'd to be very good             | as 4, 2½ to 1 |
| Regulus, made of that above, and the common way          | as 6 ¾ to 1   |
| Cinnabar of Antimony                                     | as 7 ¾ to 1   |
| Bezoar Stone   | as 1, 48 to 1 |
| —Another   | as 1, 64 to 1 |
| A fine Oriental one                                      | as 1, 53 to 1 |
| —Another   | as 1, 34 to 1 |
| A Piece of cast Brass                                    | as 7 ⅔ to 1   |
| An old Brass Gold Weight (mark'd XXXIII.)                | as 8, 83 to 1 |
| A Piece of hammer'd Brass                                | as 8, 66 to 1 |
| Coral red  | as 2, 63 to 1 |
| Chrystal   | as 2, 21 to 1 |
| Cornelian  | as 3, 29 to 1 |
| Calculus humanus   | as 1, 72 to 1 |
| —Another   | as 1, 47 to 1 |
| —Another   | as 1, 57 to 1 |
| Coco-Shell   | as 1, 34 to 1 |
| Native Crabs-Eyes  | as 1, 89 to 1 |
| Artificial Crabs-Eyes                                    | as 2, 48 to 1 |
| Calx of Lead   | as 8, 94 to 1 |
| Copper Stone   | as 4, 09 to 1 |
| Copper Ore   | as 4, 15 to 1 |
| Copper Ore rich  | as 4, 17 to 1 |
| An old Copper Half-penny (Charles II's Coin)             | as 9, to 1    |
| Common Cinnabar  | as 8, ⅓ to 1  |
| Cinnabar of Antimony                                     | as 7, 03 to 1 |
| —Another Piece   | as 7, 06 to 1 |
| Coral white  | as 2, 54 to 1 |
| Chalk, found by Dr. Slare to be                          | as 1, 2½ to 1 |
| Gold Ore, not rich, from India                           | as 2, 63 to 1 |
| —Another Lump of the same                                | as 2, 55 to 1 |
| An old Jacobus   | as 18 ⅛ to 1  |
| A Piece of Gold Commonwealth Coin                        | as 17 ⅛ to 1  |
| The Gold of a Seal                                       | as 16 1 to 1  |
| Granatiminera  | as 3, 1 to 1  |
| Granate Bohemian   | as 4, 36 to 1 |
| A Piece of common Glass Coffee-Dish of a brown Colour    | as 1, 76 to 1 |
| Hæmatites English  | as 3, 76 to 1 |
| A Hone to set Razors on                                  | as 2, 96 to 1 |
| An Icicle broken from a Grotto, found by Dr. Slare to be | as 1, 19 to 1 |
| Ivory  | as 1, 91 to 1 |
| A Piece of burnt or roasted Iron Ore                     | as 3 ⅓ to 1   |



|   | Proportion.               |
|---|---------------------------|
| A Piece of hammer'd Iron (per-haps Part Steel)      | as 7 $\frac{3}{4}$ to 1   |
| Lapis manati  | as 2, 86 to 1             |
| Lapis Lazuli  | as 2, 98 to 1             |
| Lapis Calaminaris                                   | as 4, 92 to 1             |
| Lapis Judaicus                                      | as 2, 69 to 1             |
| Lead Ore  | as 7, 14 to 1             |
| Lead (an ordinary Piece)                            | as 11, $\frac{1}{3}$ to 1 |
| —Another  | as 11, 42 to 1            |
| Lead Ore from <i>Cumberland</i> , rich              | as 7, 54 to 1             |
| A good Load-stone                                   | as 4, 75 to 1             |
| —Another  | as 4, 93 to 1             |
| Marcasites  | as 4, 45 to 1             |
| —Another from <i>Stalbridge</i>                     | as 4, 50 to 1             |
| Mercury revived from the Ore                        | as 14, to 1               |
| Manganese   | as 3, 57 to 1             |
| Mineral ( <i>Cornish</i> ) shining like a Marcasite | as 9, 06 to 1             |
| Marble white  | as 2, 7 to 1              |
| Osteocolla  | as 2, 24 to 1             |
| Pearl (a large one)                                 | as 2, 51 to 1             |
| Fine Orient Seed Pearl                              | as 2, 75 to 1             |
| Rhinoceros-Horn                                     | as 1, 99 to 1             |
| Sulphur vive  | as 2, to 1                |
| —Another very fine from <i>Germany</i>              | as 1, 98 to 1             |
| Slate ( <i>Irish</i> )                              | as 2, 49 to 1             |
| A Silver Half-crown ( <i>K. William's</i> Coin)     | as 10, 75 to 1            |
| Silver Ore, choice from <i>Saxony</i>               | as 4, 97 to 1             |
| —Another Piece                                      | as 7, to 1                |
| A Whetstone, not fine, such as Cutlers use          | as 2, 74 to 1             |
| A round Pebble-stone (within of Flint)              | as 2, 61 to 1             |
| Talc, a Piece like Lapis Amianthus                  | as 2, 28 to 1             |
| Talc ( <i>Venetian</i> )                            | as 2, 73 to 1             |
| Talc ( <i>Jamaican</i> )                            | as 3 to 1                 |
| New <i>English</i> Tin Ore, Mr. <i>Hubert's</i> ,   | as 4, 8 to 1              |
| Tin Ore, black, rich                                | as 4, 18 to 1             |
| Another choice Piece                                | as 5 to 1                 |
| Tutty   | as 5 to 1                 |
| Tin Glafs   | as 9, 55 to 1             |
| Vitrium Antimonij per se                            | as 4, 76 to 1             |
| Vitriol <i>English</i> , a very fine Piece          | as 1, 88 to 1             |
| Unicorns-horn, a Piece                              | as 1, 91 to 1             |
| Human Blood, Mr. <i>Boyle</i> found                 | as 1, $\frac{1}{2}$ to 1  |
| Serum of the Blood to Water, he found to be         | as :: 302 to 253          |
| Asphaltum, Mr. <i>Boyle</i> ,                       | as 1, 14 to 1             |
| <i>Scotch</i> Coal                                  | as 1, 13 to 1             |

A Table of Specifick Gravity, from Philosophical Transactions, Numb. 169.

|                                       | Proportion. |
|---------------------------------------|-------------|
| Pump-water                            | 1000        |
| Dried Fir                             | 546         |
| Dried Elm                             | 600         |
| Dried Cedar                           | 613         |
| Dried Walnut Tree                     | 631         |
| Crab Tree (meanly dry)                | 705         |
| Ash, meanly dry and fappy             | 734         |
| Heart Ash, pretty well dry'd          | 845         |
| Maple dry                             | 755         |
| Yew of Knot or Root sixteen Years old | 760         |
| Beach meanly dry                      | 854         |
| Oak very dry, and almost Worm-eaten   | 753         |
| Oak a Year old, but fappy             | 870         |
| Oak (Heart) found and dry             | 929         |
| Another Piece                         | 932         |

|   | Proportion. |
|---|-------------|
| Logg-wood   | 913         |
| Box   | 1031        |
| Red-wood  | 1031        |
| Speckled <i>Virginia-wood</i>                               | 1313        |
| Lignum Vitæ   | 1327        |
| Pitch   | 1150        |
| Pit-Coal of <i>Staffordshire</i>                            | 1240        |
| Glafs Bottle  | 2666        |
| Stone Bottle  | 1777        |
| Ivory   | 1826        |
| Alabaster   | 1872        |
| Brick   | 1979        |
| <i>Heddington-stone</i> , of the soft lax kind              | 2029        |
| <i>Burford-stone</i> , an old dry Piece                     | 2049        |
| <i>Paving-stone</i> , a hard Sort from about <i>Blaidon</i> | 2460        |
| Flint   | 2542        |
| Black <i>Italian</i> Marble                                 | 2704        |
| White <i>Italian</i> Marble                                 | 2718        |
| Block-Tin   | 7312        |
| Copper  | 8843        |
| Lead  | 11345       |
| Quick-silver  | 14019       |
| Quick-silver, another Parcel more care-fully weigh'd        | 13595       |
| Claret  | 993         |
| Urine   | 1033        |
| Moil Cyder, not clear                                       | 1017        |
| Sea-water, clear  | 1028        |
| College Plain Ale   | 1028        |
| Milk  | 1031        |
| Sack  | 1033        |
| Beer Vinegar  | 1034        |

A Table of Specifick Gravity, by Mr. J. C. from Philosophical Transactions, Numb. 199.

|  | Proportion. |
|--|-------------|
| Cork   | 237         |
| Sassafras-wood   | 482         |
| Juniper-wood (dry)                                     | 556         |
| Plum-Tree (dry)  | 663         |
| Mastic   | 849         |
| Santalum Citrin  | 809         |
| Santalum Album   | 1041        |
| Santalum Rubrum  | 1128        |
| Ebony  | 1177        |
| Lignum Rhodium   | 1125        |
| Lignum Asphaltum                                       | 1179        |
| Aloes (I believe he means the Wood)                    | 1177        |
| Succinum Pellucidum                                    | 1065        |
| Succinum Pingue  | 1087        |
| Jet  | 1238        |
| The Top Part of a Rhinoceros's Horn                    | 1242        |
| The Top Part of an Ox-horn                             | 1840        |
| The Blade-bone of an Ox                                | 1656        |
| Calculus humanus                                       | 1240        |
| Another  | 1433        |
| Another  | 1664        |
| Common Brimstone                                       | 1811        |
| Borax  | 1720        |
| A spotted factitious Marble                            | 1822        |
| A Gally-pot  | 1928        |
| Oyster-shell   | 2092        |
| Murex-shell  | 2590        |
| Lapis Manati   | 2270        |
| Selenitis  | 2322        |
| Wood petrefied in <i>Lough Neagh</i> in <i>Ireland</i> | 2341        |
| Onyx-stone   | 2510        |
| Turcois-stone  | 2508        |
| <i>English</i> Agate                                   | 2512        |



|  | Proportion. |
|--|-------------|
| Grammatias Lapis                                   | 2515        |
| Cornelian  | 2568        |
| Corallachates                                      | 2605        |
| Talc   | 2657        |
| Coral  | 2686        |
| Hyacinth (Spurious)                                | 2631        |
| Jasper (Spurious)                                  | 2666        |
| A Pellucid Pebble                                  | 2659        |
| Chryſtallum Diſdiachſticum                         | 2704        |
| A Red Paſte  | 2842        |
| Lapis Nephriticus                                  | 2894        |
| Lapis Amiantus, from <i>Wales</i>                  | 2913        |
| Lapis Lazuli                                       | 3054        |
| A Hone   | 3288        |
| Sardaketes   | 3598        |
| A Granate  | 3978        |
| A Golden Marchaſite                                | 4589        |
| A blue Slate, with ſhining Particles in it         | 3500        |
| A Mineral Stone, yielding one Part in 160 of Metal | 2650        |
| The Metal extracted thence                         | 8500        |
| The Silver Ore of <i>Wales</i> (as it is reputed)  | 7464        |
| The Metal thence extracted                         | 11087       |
| Biſmuth  | 9859        |
| Spelter  | 7065        |
| Spelter Soder                                      | 8362        |
| Iron of a Key                                      | 7643        |
| Steel  | 7852        |
| Caſt Braſs   | 8100        |
| Wrought Braſs                                      | 8280        |
| Hammer'd Braſs                                     | 8349        |
| A falſe Guinea                                     | 9075        |
| A true Guinea                                      | 18888       |
| Sterling Silver                                    | 10535       |
| A Braſs Half Crown                                 | 9468        |
| Electrum (a <i>Britiſh</i> Coin)                   | 12071       |
| A Gold Coin of <i>Barbary</i>                      | 17548       |
| A Gold Medal from <i>Morocco</i>                   | 18420       |
| A <i>Mentz</i> Gold Ducat                          | 18261       |
| A Gold Coin of <i>Alexander's</i>                  | 18893       |
| A Gold Medal of <i>Queen Mary</i>                  | 19100       |
| A Gold Medal of <i>Queen Elizabeth</i>             | 19125       |
| A Medal eſteemed to be near fine Gold              | 19636       |

**SPECIFICK Medicines**, are ſuch as have a peculiar Virtue againſt ſome Diſeaſe; as the *Quinquina*, or *Cortex Peruviana*, hath to cure Intermittent Fevers: And Phyſicians mention in their Books three kinds of Specifick Medicines.

1. Such as are eminently and peculiarly friendly to this or that Part of the Body, as to the Heart, the Brain, the Stomach, &c.

2. Such as do ſeem to attract, expel or evacuate ſome determinate Humour by a kind of Specifick Power, that they are endowed with. Thus *Jalap* purges watry Humours, *Rhubarb Bile*, &c. And,

3. Such as have a Virtue to cure, by ſome hidden Property, this or that particular Diſeaſe.

That there are ſuch Medicines as theſe, in the latter and moſt proper Senſe of the Word, Mr. *Boyle* makes very probable, by theſe Reaſons.

1. The concurrent Teſtimony of Experience both Ancient and Modern. *Galen* promiſed a Book on this Subject, but it is loſt if he ever wrote it.

2. 'Tis manifeſt that inconfiderable Quantities of Poiſon can do very great Miſchief, and produce great and diſmal Effects, without any manifeſt Quality appearing to be in them: And therefore by Parity of Reaſon one would conclude, Medicines may be found which ſhall heal and do good the ſame way.

3. The Teſtimony of Phyſicians themſelves, who in their Writings do always mention ſome one Specifick or other, which they believed was really ſuch.

And certainly it would be well worth while to keep an account of the Operations of as many pretended Specificks as can come to any Phyſician's Knowledge, and by no Means to reject all things of that Nature, becauſe a Reaſon cannot preſently be given for the Cure; for if we ſhould always do ſo, we muſt reject almoſt every thing.

**SPECILLUM**, is a Surgeon's Inſtrument called uſually a *Probe*, by which he ſearches the Depths, Windings, &c. of Wounds and Ulcers.

**SPECIOUS Arithmetick** is that which is converſant about Quantities deſign'd by *Species*; i. e. by Letters of the Alphabet, in Contradiſtinction to that where the Quantities are expreſ'd by Numbers, and is called *Numerous Arithmetick*.

**SPECULUM Ani**, in Surgery, an Inſtrument to dilate the Fundament, examine Sores; extract Bones, or let out any peccant Matter that may be lodged there.

**SPECULUM Lucidum**: See *Septum Lucidum*.

**SPECULUM Matricis**, in Surgery, an Inſtrument uſed in examining corrupted Places in the Natural Parts of Women.

**SPECULUM Oculi**, the Apple or Pupil of the Eye. See *Aranea Tunica Oculi*.

**SPECULUM Oris**. See *Dilatatorium*.

**SPELL**, a *Sea Word*, ſignifying to let go the Sheats and Bowlings of a Sail (chiefly the Miſſen) and bracing the Weather-Brace in the Wind, that the Sail may lie looſe in the Wind. This is done when a Sail hath too much Wind in it, and there is Danger of wronging the Maſt. This Word is moſtly uſed about the *Miſſen ſail*: For there inſtead of ſaying take in the *Miſſen* and *peak it up*, they ſay in one Word *Spell the Miſſen*.

To do a *Spell* alſo with them, ſignifies doing any Work for a ſhort time, and then leaving it: Therefore a *Freſh Spell* is when freſh Men come to work; and to *give a Spell*, is all one as to ſay work in ſuch a one's Room.

**SPENT**. The Seamen ſay a Ship hath *Spent* any Maſt, or Yard, when it is broken down by foul Weather, or any ſuch Accident: But if it be done by an Enemy's Shot in Fight, they ſay, ſuch a *Yard or Maſt was ſhot by the Board*.

**SPERMATICK Veſſels**, and *Parts*, are thoſe Arteries and Veins which bring the Blood to, and convey it from the Teſticles: Likewise thoſe Veſſels through which the Seed paſſes: Likewise all whitish Parts of the Body, which becauſe of their Colour, were anciently thought to be made of the Seed. Of this Sort are the Nerves, Bones, Membranes, Griſtles, &c.

**SPERMATOCELE** [of *σπέρμα* Seed, and *κελή*, Gr. a Rupture] a Rupture cauſed by the Contraction of the Veſſels which eject the Seed, and its falling down into the *Scrotum*.



**SPHACELUS** [ $\sigma\phi\acute{\alpha}\kappa\epsilon\lambda\omicron\varsigma$ , Gr.] is a sudden Extinction of Life and Sense in every Part.

**SPHÆNOIDALIS Sutura**, is a Suture that surrounds the *Os Sphænoides*, separates it from the *Os Occipitis*, from the *Os Petrosum*, and from the *Os Frontis*.

**SPHÆNOIDES** [ $\sigma\phi\eta\nu\omicron\epsilon\iota\delta\eta\varsigma$ , Gr.] is a Bone of the *Cranium*, common both to the Skull and the upper Jaw; it is of a very irregular Figure, and is situated in the middle of the Basis of the Skull, and is joined to all the Bones of the *Cranium* by the *Sutura Sphænoidalis*, except in the middle of its Sides, where it is continued to the *Offa Petrofa*, as if they were one Bone. This Bone has a small Protuberance in the middle thereof, from which the Muscles of the *Uvula* arise: On its Inside it has four Processes called *Clinoides*. Betwixt the two Tables of this Bone, under the *Cella Turica*, there is a *Sinus* divided in two in the middle, which opens by two Holes into the Cavity of the Nostrils. In this Bone some say there are also twelve Holes; by the first and second pass the Optick Nerves, by the rest pass other Nerves for the Motion of other Parts, as also of Veins and Arteries.

**SPHÆNOPALATINUS** is a Muscle of the *Gargareon*, which descends from a round fleshy Origination, at a Process of the *Os Sphænoides*, which is in a direct Line between the *Ala Vespertilionis*, and *Processus Styloides*, thence it becomes a round fleshy Belly in half its Progress, grows less again near its lateral Insertion to the posterior Part of the *Gargareon*.

This with its Partner acting, draw the *Gargareon* with the *Uvula* upwards and backwards, which hinders the masticated Aliment from Regurgitating through the *Foramina Narium* in *Deglutition*.

**SPHÆNOPHARINGÆUS** [of  $\sigma\phi\eta\nu\omicron\epsilon\iota\delta\eta\varsigma$  and  $\phi\acute{\alpha}\rho\upsilon\gamma\acute{\iota}\varsigma$ , Gr.] is a Pair of Muscles arising from the *Sinus* of the inner Wing of the *Os Cuneiforme*, and going obliquely downwards, is extended into the Sides of the Gullet; it dilates the Gullet.

**SPHÆNOSTAPHYLINUS** [of  $\sigma\phi\eta\nu\omicron\epsilon\iota\delta\eta\varsigma$  and  $\sigma\tau\alpha\phi\upsilon\lambda\eta$ , Gr. a Grape] a Muscle of the *Pharynx* descending from a round fleshy Origination near the Root of a Process of the *Os Sphænoides*, and implanted in the posterior Part of the *Uvula*, where it joins its Partner. The Use of it is to assist in drawing the *Uvula* upwards and backwards, and to hinder the masticated Aliments to pass into the *Foramina Narium* in *Deglutition*.

**SPHÆNOIS**. See *Os Cuneiforme*.

**SPHÆNOPTERIGOPALATINUS**. See *Pterigopalatinus*.

**SPHAGITIDES** [ $\sigma\phi\alpha\gamma\acute{\iota}\tau\iota\delta\epsilon\varsigma$ , Gr.] according to some, are the Jugular Veins in the Neck.

**SPHERE** [ $\sigma\phi\acute{\alpha}\iota\epsilon\alpha$ , Gr.] is a Solid Body made by the Rotation of a *Semicircle* about its Diameter.

1. All Spheres are to one another as the Cubes of their Diameters. For under the Word *Cylinder* you will find it proved, *That Cylinders whose Altitudes are equal to the Diameters of their Bases, are in Proportion to each other as the Cubes of their Diameters*; which is thus express'd,  $\frac{1}{4} r d d d : \frac{1}{4} r D D D :: d d d : D D D$ . Wherefore, be the Ratio of a Sphere to a Cylinder of the same Diameter and Height to it, what it will (and what it is, is shewn in another Place) call it  $y$ : Therefore  $\frac{1}{4} r d d d : \frac{1}{4} r D D D ::$

$\frac{1}{4} r y d d d : \frac{1}{4} r y D D D$ . But  $\frac{1}{4} r y d d d : r y D D D :: d d d : D D D$ . That is, Spheres are to each other as the Cubes of their Diameters. Q. E. D.

2. The Solidity of a Sphere is equal to the Surface multiplied into one Third of the Radius; as is proved from *Cor. 1. of Prop. 4. in the Word Cylinder*.

3. A Sphere is equal to two Thirds of a Cylinder, having the Diameter of its Base and its Axis equal to that of the Sphere; i. e. a Sphere is two Thirds of the Cylinder circumscribed: And the Surface of the Sphere, and the curved one of the Cylinder circumscribing it, is the same in Quantity; as is proved in *Cylinder, Prop. 4. and Corollaries*; as also very briefly under the Word *Indivisibles*.

4. The Surface of the Sphere is equal to four times the Area of a great Circle. See *Cylinder, Prop. 4. Coroll.* Wherefore add to the Curved Surface of the Cylinder its two circular Bases, and that will make six great Circles of the Sphere: So that the Surface of the Sphere is but two Thirds of the whole Surface of the Cylinder. See also *Cylinder*.

An entire Sphere of Glass will unite the parallel Rays of any Object at the Distance of near its Semi-diameter behind it. *Molyneux Dioptr. p. 93.*

**SPHERE**. 1. The Surface of a Sphere is equal to the Periphery of a great Circle, multiplied by its Diameter. *Hayes, p. 37.*

2. The Area of any Segment of a Sphere cut off by a Plane, or by two Planes which are parallel, is to the whole Spherical Surface, as the intercepted Portion of the Diameter is to the whole Diameter. Wherefore putting  $r$  = Radius,  $c$  = Periph. and  $x$  = the intercepted Diameter; the Area of any Segment may be found by this Proportion.

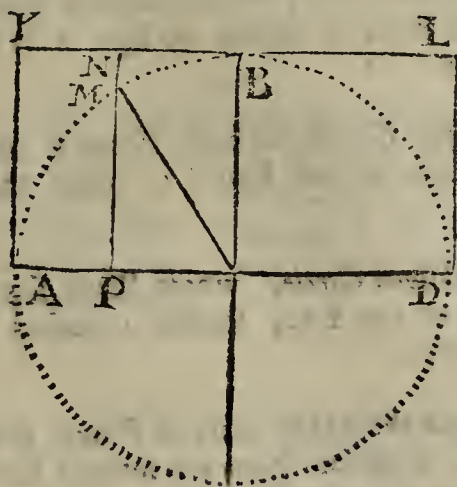
$$2 r : x :: 2 r c : c x.$$

The Part of the Sphere's Surface contain'd between the Semicircular Arks of any two (Great) intersecting Circles, is to the whole Surface as the Angle of Inclination of the Planes of those Circles is to four right Angles.

3. When the Diameter of any Sphere is equal to the Radius of any Circle, then the Area of that Circle will be equal to the Surface of the corresponding Sphere.

4. The Convex Area of a Cylinder circumscribing a Sphere of the same Diameter with its own Altitude (which in this Notation will be  $2 r c$ ) is Quadruple of the Area of the Base; and consequently = to the Area of the Surface of the Sphere, and the Surface of an Hemisphere is = to twice the Area of one of its great Circles.





5. Suppose the Square A L, together with the Semieircle A B D, to revolve round A D as an Axis; then will the Line K L generate a Cyllindrick Surface = to the Hemispherical one generated by the Semicircle (by 3): Wherefore if any Point, as M, be assigned, and through it P N be drawn Normal to A D; I say, the Surface or Ring described by K N, will be equal to the Segment described by the Ark A M. For the Ring described by K N, will be to the whole Cyllindrick Surface, described by K L, as K N, K L. And the Segment made by the Revolution of the Ark A M, is to the whole Spherick Surface, as A P, A D, that is, as K N, K L. Wherefore, &c.

About the Dimensions of the Sphere and Cylinder; see Dr. Wallis in *Philosophical Transactions*, Numb. 263, p. 547.

**SPHERE of Activity**, of any Body, is that determinate Space or Extent all round about it, to which, and no farther, the *Effluvia* continually emitted from that Body do reach, and where they operate according to their Nature. Thus we see the *Magnetical Effluvia* have certain Bounds and Limits, beyond which they will have no Influence to turn or to attract the Needle: But where-ever a Needle be placed, so as that it can be moved by a Loadstone, it may be said to be within the *Sphere of Activity* of the Stone.

A **Right SPHERE**, is one where the Equator cuts the Horizon of the Place at right Angles.

A **Parallel SPHERE**, is where the Equator is parallel to the Sensible Horizon, and in the Place of the Rational.

An **Oblique SPHERE**, is where the Equator cuts the Horizon Obliquely.

**Armillary SPHERE**, in *Astronomy*, is an **Artificial SPHERE**, a instrument representing the several Circles of the Sphere in their Natural Order, and serving to represent or give an Idea of the Office and Position of each thereof, and to solve the various Phenomena relating to it.

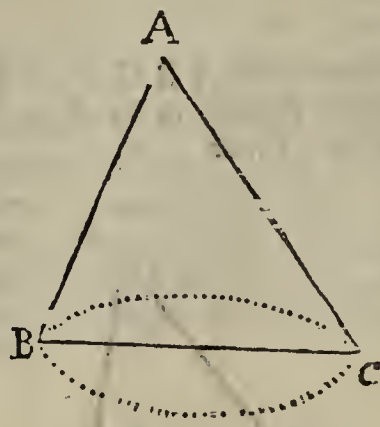
**SPHERICK Geometry**, or *Projection*, is the Art of describing on a Plane the Circles of the Sphere, or any Parts of them in their just Position and Proportion, and of measuring their Arks and Angles when projected.

As an Introduction to which, you must understand.

## PROPOSITIONS.

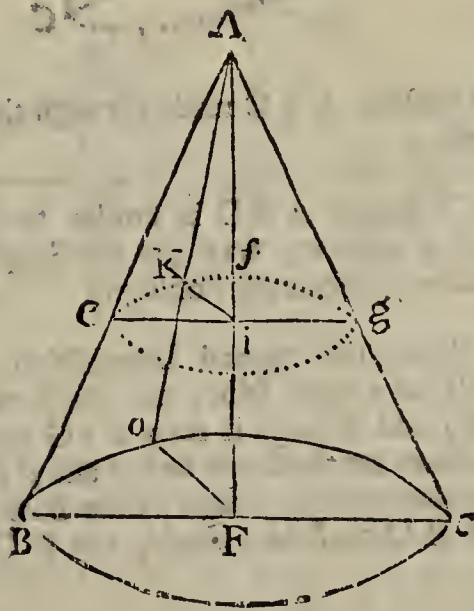
1. If a Cone, as A B C, be cut by a Plane, either by the Axis, or through the Vertex, the Section will be a Triangle.

V O L. II.



For the Point A is the Vertex of the Cone, and will be so of the Triangle, and B C is a right Line, because 'tis the Diameter of the Circle of the Base, and A B and A C must be Right Lines, because the Surface of the Cone will be described by either of them; wherefore the Section A B C is a Triangle. Q. E. D.

- II. If a Cone, as A B C, be cut by a Plane parallel to its Base, the Section e f g h will be a Circle.



For let F be the Center of the circular Base, then will A F be the Axis; and if the Cone be cut by the Axis, the Section A B C will be a Triangle. Let e g, the Diameter of the Section, be drawn, cutting the Axis in i, wherefore e g, the Diameter of the Section, will be parallel to B C, the Diameter of the Base.

And consequently,

$$A F : F B :: A i : i e : \text{ and } \\ \text{as } A F : F C :: A i : i g.$$

Wherefore, by *Inverse Proportion*, and *ex æquo*, as  $F C : F B :: i g : i e$ .

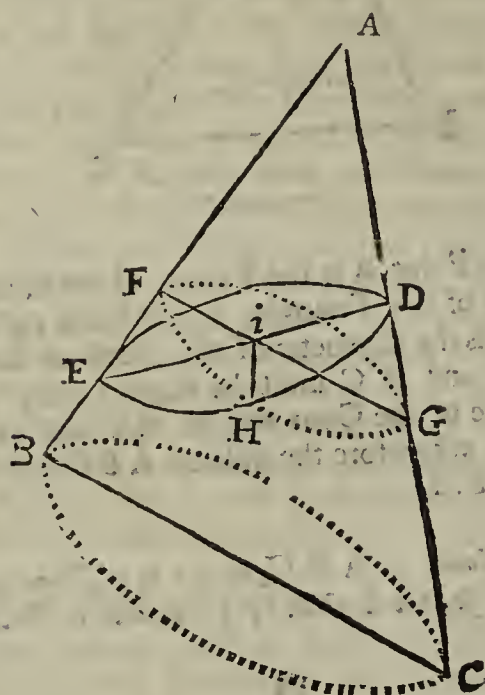
But  $B F = F C$ ; therefore  $i e = i g$ .

And the same Consequence will arise if you take o and K, any two other Points in the Base and in the Section; for K i being parallel to o F, and A o F being a Triangle.  $A F : o F :: A i : K i$ , but as  $A F : F B :: A i : i e$ . Wherefore, *ex æquo*,  $o F : F B :: K i : i e$ . And therefore K i and i e are equal also, and consequently the Section is a Circle: For i is a Point from whence more than



than two Right Lines drawn to the Curve  $ebgf$  are equal; wherefore that Curve must be a Circle. *Q. E. D.*

III. If a Scalenous Cone  $ABC$  be cut by a Plane in a subcontrary Position to its Base, the Section  $DEH$  will be a Circle.



1. The Section  $ABC$  made through the Axis, is a Triangle.

2. The Triangle  $AED$  is similar to  $ABC$ , tho' placed a contrary way (by the Supposition, which is called subcontrary Position.)

3.  $ED$  being the mutual Intersection of two Planes, will be a right Line, on which take any Point, as  $(i)$  and through it draw  $FiG$  parallel to  $BC$ , and there let the Cone be cut also; then the Plane that cuts it being parallel to the Base of the Section,  $FHG$  must be a Circle, and  $FG$  a Diameter.

Now, because both these Intersecting Planes are Right to the Plane of the Triangle  $ABC$ , their common Intersection  $IH$  will also be a right Line, and perpendicular to the Plane of the Triangle, and to the two Lines  $ED$  and  $FG$ . And then, because the Triangles  $ABC$ ,  $AED$ , and  $AFG$  are all Similar, the Angles at  $G$  and  $E$  must be equal; and the Vertical ones at  $i$  being so too, the Triangle  $FEi$  must be Similar to  $iDG$ . Wherefore  $Di : iG :: Fi : iE$ ; therefore  $UDiE = UF iG$ ; but because  $FG$  is the Diameter of a Circle, and  $iH$  perpendicular to it, and terminated at the Circumference, 'twill be a middle Proportional between the Segments of the Diameter, and have its Square equal to the Rectangle  $FiG$ , (as also to its Equal  $EiD$ ); wherefore the Point  $H$  is in the Circumference of a Circle, whose Diameter is  $DE$ . *Q. E. D.*

#### DEFINITION I.

A Circle of the Sphere, as to its Projection on any Plane, is of four kinds.

1. The Primitive Circle, or Limb which bounds the Projection, and within which it is always made.

2. A Direct Circle, whose Plane is directly opposite to the Eye, or when the Eye is in the Axis of the Plane.

3. A Right Circle, whose Plane is coincident with the Axis of the Eye; or with the visual Rays.

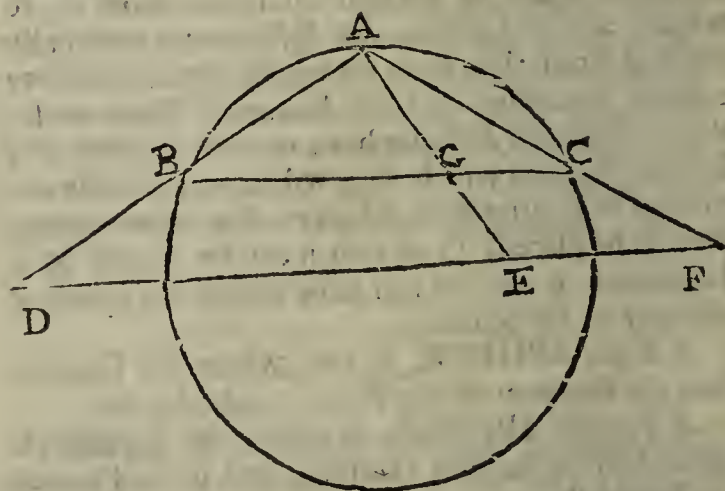
4. An Oblique Circle, whose Plane lies oblique to the Axis of the Eye, so that it makes unequal Angles with it.

To Project the Sphere truly in Plano, is a Part of Perspective, whereof there are several kinds; but the most usual is what is properly called the Stereographick, or solid Projection of the Sphere; and the Orthographick, or the Analemma: The latter of which see in Analemma.

In the former, the Circles of the Globe are drawn or represented on a Plane, which passes through its Centre, and hath the Eye supposed to be in the Pole, or  $90^\circ$  distant from it; Projecting the several Circles, or Arcs of Circles on that Plane, or on any one parallel to it.

In this Projection, if a Line pass through the Eye, or be coincident or parallel to the Axis, it will be represented by a Point.

IV. If a Line be direct to the Eye, it will be projected into a Right Line, whose Parts will be in the same Proportion to one another, as those of the Primitive Line, of which it is the Representation.

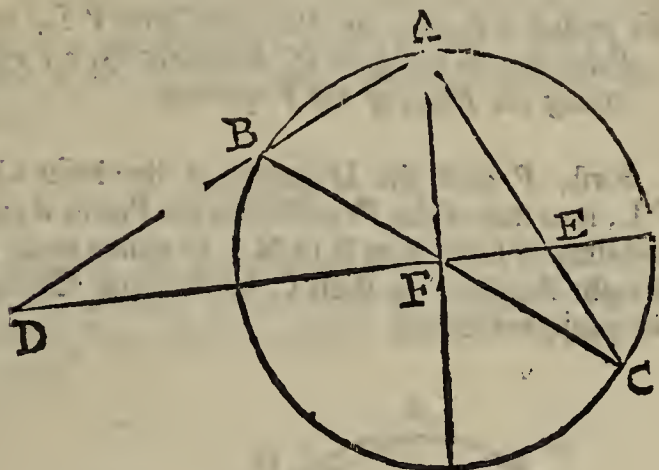


For since the Line  $BC$  (which may be the Diameter of a parallel Circle) is supposed to lie parallel to  $DE$ , and is projected into it from the Eye at  $A$ , if you draw the Lines  $AD$ ,  $AE$ , and  $AF$ , the Triangles  $ABG$  and  $ADE$  will be similar; as also will  $AGC$  and  $AEF$ ; wherefore as  $AB : AD :: BC : DE$ ; and as  $AB : AD :: AG : AE$ ; also as  $AG : AE :: BG : DE :: GC : EF$ . Wherefore as the whole  $BC$  to the whole  $DE ::$  the Part  $BG$  to the Part  $DE :: GC : EF$ .



## P R O P. V.

But if a Line lie obliquely to the Eye, the Parts of it in the Projection will not be in the same Proportion, as they are in the Line it self; but those Parts of it which lie nearest to the Eye, will in the Projection appear longer than those which lie more remote from it.



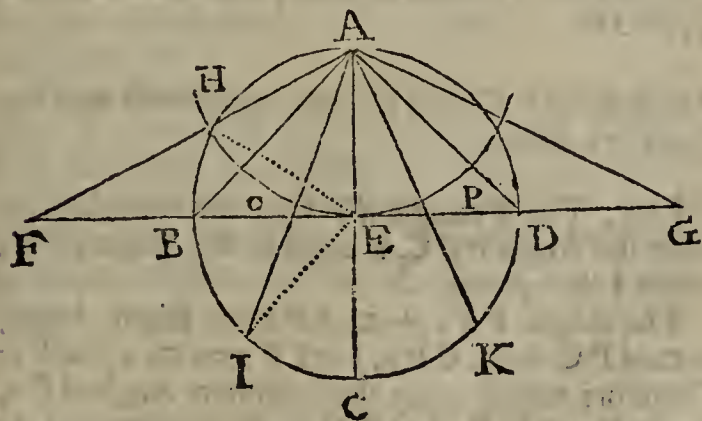
Thus, if the Eye be at A, I say the Line B C lying oblique to it, will be projected into the Line D E; and its half B F, which lies nearer to the Eye, shall be represented by the Line D F, which is longer than F E, the Representation of the other half which lies remote from the Eye; as is in a manner self evident.

If a Circle be right to the Eye, or hath its Plane coincident with, or parallel to its Axis, it will be projected into an infinite right Line.

## P R O B L E M I.

**Prop. 6.** To represent on the Plane of the Projection a Right Circle, and to distinguish there such Parts and Divisions as shall truly correspond to those of the Right Circle given.

Let the Circle given be A B C D; and let it be divided into eight equal Parts, as in the Figure; and let the Eye be at A. Draw F G at right Angles to A C, the Axis of the Eye, to represent the Plane of the Projection; and draw also from A, A F, A B, A I, A C, A K, A D, A G, through the several Divisions of the given Circle: Then will F B, B O, O E, E P, P D, and D G, be the proper Representations of the Parts of the given Circle.



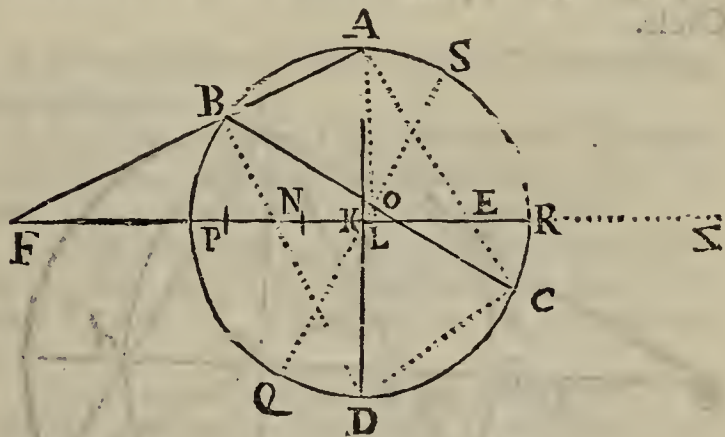
And if on A as a Centre, with the Distance A E, another Circle be described, 'ts plain that O E, E B, and E F, &c. will be Tangents of the An-

gles O A E, B A E, F A E, &c. at the Circumference, which are severally the Halves of the Angles I E C, B E C, H E C, &c. at the Centre: Of which latter Angles, the Arks of the Circle given C I, C B, and C H, are the proper Measures: wherefore the Right Lines O E, B E, F E, &c. are the Tangents of half those Arks; which shews us that every Diameter of a great Circle, or its Parts within or without the Primitive, is to be measured on the Scale of half Tangents; and that the Divisions of it begin at the Centre of the Primitive Circle.

## P R O P. VII.

A Circle placed obliquely to the Eye at A, will be a true Circle in the Projection; but its true Centre is different from its apparent one.

Let B C be the Diameter of an oblique Circle, which is to be projected from the Eye at A, on a Plane represented by the Line F R, which Mr. Oughtred calls the Line of Measures.



1. 'Tis plain the Diameter B C will be represented by the Line F E. 'Tis also plain, that if right Lines were drawn from A to all the Parts of the oblique Circle, of which B C is the Diameter, they would make an oblique Cone of Rays, as A B C.

2. But I say that the Scalenoous Cone of Rays A B C is cut by the Plane F R *subcontrarily* to its Base, and consequently the Section will be a Circle (by the 3d); wherefore the given oblique Circle will always be represented by a Circle on the Plane of the Projection.

That the Scalenoous Cone A B C is cut *subcontrarily* to its Base, may be thus proved.

Draw A D through the Centre of the Sphere K, and join B D and C D.

The Angle A C D is a right one (being in a Semicircle) and the Angle A K E is right, by Supposition and Construction; and the Angle D A C is common to the two Triangles A K E and A D C; wherefore they are similar, and consequently the Angle A D C is equal to the Angle A E K.

But the Angle A D C is equal to the Angle A B C, as being in the same Segment; and the Angle A D C was before proved = to the Angle A E K; wherefore the Angle A B C = Angle A E K; and since the Angle A B C is common to both, therefore the Angle F must be equal to the Angle C, and consequently the Cone A B C is cut *subcontrarily*; and therefore F E is the Diameter of a true Circle, whose real Centre will be in P, the middle Point; but the apparent Centre of the Circle will be at L, where



where the Point O (which is the middle Point of B C) is projected.

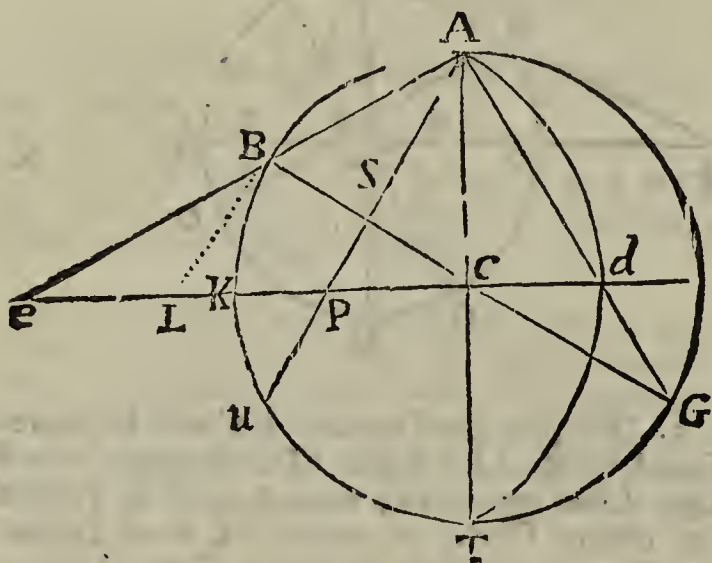
There are several other ways of finding P the Centre of the *Projected Circle*; but this is as expeditious as any.

To project the Poles of the oblique Circle B C, draw through K, the Centre of the Sphere, a right Line, as Q S, perpendicular to B C, which therefore will be the Axis of the oblique Circle: Then a Ruler laid from A through Q and S, the Pole of that Axis shall project the Polar Points in N and Z.

## P R O P. VIII.

The Centre (P) of every great Circle (B G) which lies oblique to the Primitive (in the Projection) is so far distant from C, the Centre of the Primitive, as is the Tangent of the Ark of Elevation of its Plane above the Plane of the Primitive.

Make the Ark B u = G T, the Complement of the Angle of Elevation, and draw u A, which will find the Point P, the Centre of the Projected Circle.



## D E M O N S T R A T I O N.

Because the Angle B A u = Angle C A G (as being on equal Arches) and the Angles A B G equal to the Angles A d e (by the subcontrary Position) therefore the Triangles B A S and A C d are similar, and consequently the Angle B S A (which is equal to the Angle A C d) is a right one.

Draw B L perpendicular to B C; wherefore, the Triangles B L C and A P C are similar; for Angle B L C = Angle P C A, as being both right ones; and the Angle A P C = B L C, because B L and A P are Parallels; wherefore the Angle B C L = Angle P A C.

But P C is the Tangent of the Angle P A C, and therefore of its Equal the Angle B C L, or of the Ark B K, which is equal to the oblique Circle's Elevation above the Plane of e d; wherefore P, the Centre of the oblique Circle, is distant from C by the Tangent of its Elevation above the Plane e d. Q. E. D.

## C O R O L.

Also, because the Triangles e P A and A C G are similar (as having Angle e = Angle G, by subcontrary Position) and the Angle B A P = An-

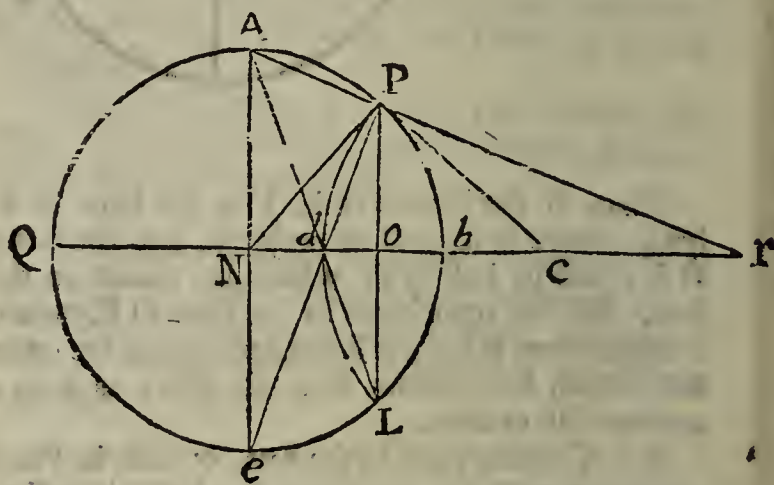
gle C A G (as being on equal Arks); therefore will e P : P A :: A C : C G; that is, e P = P A. But P A is the Secant of the Angle P A C, or of the Ark B K; wherefore the Secant of the Elevation e P set from e, shall find P the Centre as before; P e, P A, or P d being its Radius.

## P R O P. IX.

## Problem 2.

To project a Lesser, or Parallel Circle P L, whose Poles are in the Line of Measures Q, r; representing the Plane of the Projection.

First, Project the Diameter of the lesser Circle P L, into that of the Projection in the Points d and r, and draw a Line from P to N; to which erect P C at right Angles; so shall C be the true Centre of the projected Circle.



## D E M O N S T R A T I O N.

The Angle N A P is equal to the Angle O P r, because A N is parallel to P O; also the Angle A e P is equal to the alternate Angle e P L; but the Angle e A P, added to the Angle e, is equal to a right one. Wherefore the Angle O P r + P r O, = a right Angle: That is, the Angle d P r, is a right Angle. Wherefore d r, is the Diameter of a Circle.

Now N P C, being right by Construction, take from those two right Angles the common one d P C, and the Angle N P d (= e) must remain equal to the Angle C P r, and the Angle r, is = to the Angle e, because the Triangles N d e, and P d r are similar: Wherefore the Triangles P C r, and N P e are similar; and consequently e N : N P :: P C : C r, but e N = N P; therefore P C = C r. Therefore both are Radii of a Circle. Q. E. D.

And to prove P C = d C, and consequently that they also are Radii,

I say, The Triangle d P C, is an Isosceles, because the Angle P d C, is equal to the Angle d P C; which I thus prove.

The Angle P d o + e d P o = Right Angle, = e d P C + e C P r, but C P r = e = d P o: Therefore taking away the common Angle d P o, (or its Equal C P r) d P C must remain equal to P d C: wherefore P C (= C r) = C d. Wherefore o is the true Centre of the projected Circle.



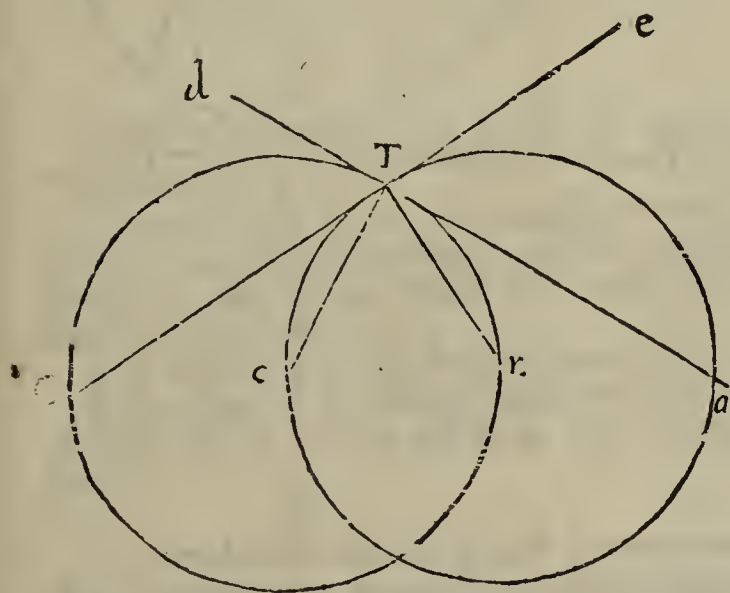
## COROLLARY I.

1. Hence 'tis plain, that making  $NP$  the Radius of a Circle, whose Centre is  $N$ , the projected Circle's Centre  $C$ , is distant from  $N$ , the Centre of the Primitive, by  $NC$ ; the Secant of the Ark  $Pb$ , or of that lesser Circle's Distance from its Pole  $b$ .

2. The Semi-diameter of this projected Circle ( $Cd$ ) is equal to ( $CP$ ) which is the Tangent of the said Ark  $Pb$ , or of that Circle's Distance from its Pole.

## PROP. X.

*The Angle of the Intersection of any two Circles on a Plane, is equal to the Angle made by their Radii drawn from their Centres to the Point of Intersection.*



I say, the Rectilinear Angle  $cTn$ , made by the two Radii  $cT$ , and  $Tn$ , is equal to the Curvilinear Angle  $oTc$ , made by the Arks  $oT$ , and  $cT$ ; which is equal also to the Curvilinear Angle  $nTa$ , made by the Arks  $nT$ , and  $Ta$ .

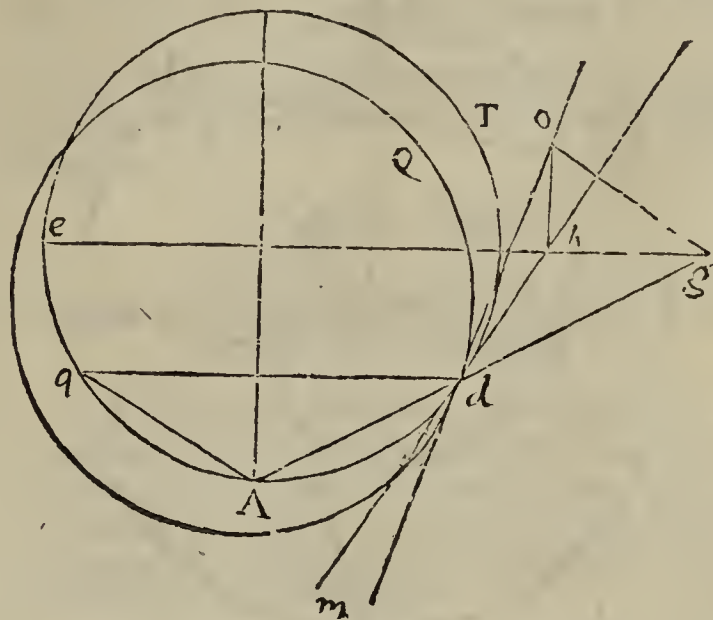
Draw  $oT$ , and  $Ta$ , Tangents to the intersecting Circles.

Then the Angles of Contact  $oTc$ , and  $nTa$ , which are made by the Tangents and the Curves, being less than any acute ones, and indeed no Quantity; the Tangent  $oTe$ , and  $dTa$  will fall in with the Circles, and make the same Angles with one another, as the Arks of those Circles do: Wherefore the Curvilinear Angle  $oTc$ , is equal to the Rectilinear one  $oTd$ ; and on the other side the Curvilinear Angle  $nTa$  is equal to the Rectilinear one  $aTe$ .

Wherefore since the Right-lin'd Angles  $dTe$  and  $oTn$  are both Right Angles, and equal, if you take away the common Angle  $oTc$ , the Angle  $dTo$ , must be equal to the Angle  $cTn$ ; and consequently the Angle  $eTn$  is equal to the Angle of Intersection  $oTc$ . Q. E. D.

## PROP. XI.

*All Angles made by Circles on the Superficies of the Sphere, are equal to those made by their Representatives on the Plane of the Projection.*



Let there be two Circles,  $Q$  and  $T$ , intersecting each other at  $d$ .

I say, the Angle  $QdT$ , made by the Planes of these Circles, is equal to the Angle  $ogh$ , made by their Tangents  $od$ , and  $dh$ , when projected.

Let the Eye be at  $A$ , and the Point of Intersection  $d$ ; then draw  $dh$ , a Tangent to the outer Circle  $dT$ , and  $do$ , a Tangent to the inner Circle  $dQ$ .

Then, since the Plane of the Projection  $eg$ , as also that made by the Tangents  $dh$ , and  $do$  (which are in the same Plane) are both perpendicular to the Plane of the Circle  $eTdA$ ; their common Intersection  $oh$  must be a right Line, and also perpendicular to  $eg$ .

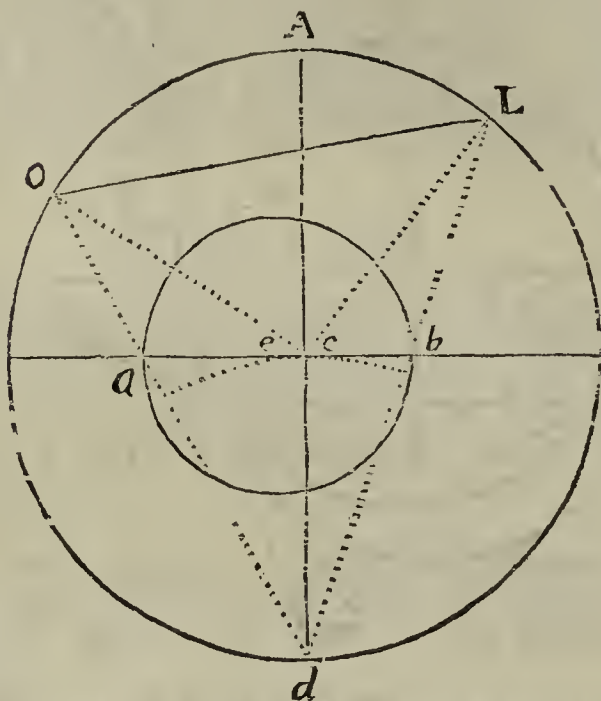
Draw all the Lines, as in the Figure; then will the Angle  $Adm$  (made by the Tangent and Secant) be equal to the Angle  $q$  (in the opposite Segment) which is equal to  $qda$ , because the Triangle  $qAd$  is an *Isosceles*; but the Angle  $qda = \angle hgd$ , because  $qd$  is parallel to  $eg$ : Therefore the Angle  $hgd = \angle Adm =$  Vertical Angle  $hgd$ : Wherefore the Triangle  $hdg$ , is an *Isosceles*, and consequently  $dh = hg$ .

Hence the Triangle  $odh$ , hath two Sides,  $oh$ , and  $hd$ , and the right Angle  $ohd$ , equal to two Sides, and one Angle, in the Triangle  $ogh$ : Wherefore all things are equal, and consequently the Angle  $ogh$  is equal to the Angle  $odh$ , equal to the Curvilinear Angle  $QdT$ . Q. E. D.



P R O P. XIII.

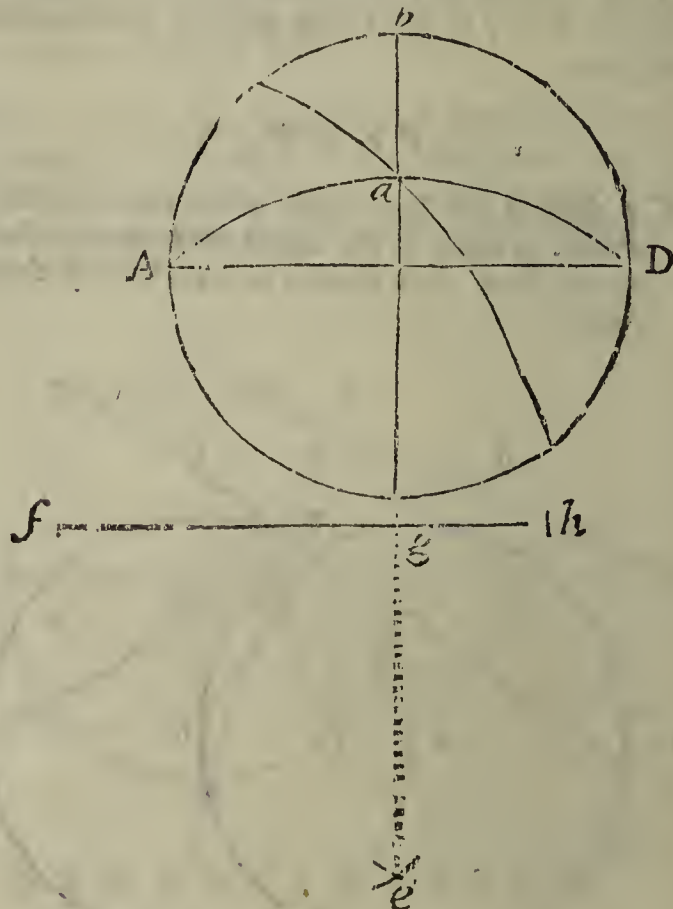
*All Great Circles of the Sphere, passing through any Point a, in the Diameter of the Projection, shall have their Centres in the Line g f, which is perpendicular to the Diameter g b, and their Centres will be distant from the Point g, the Centre of the Circle A a D, by the Tangent of the Angle of their Intersection with the said Circle A a d.*



Let  $OL$  be the Diameter of such a Circle, a Ruler from the Point  $d$ , where the Eye is supposed to be placed, to  $O$ , will project the Point  $a$ ; and from  $d$  to  $L$ , will project the Point  $b$ : Therefore  $ab$  is the projected Diameter, and consequently its middle Point  $e$  will be the Centre of that Circle in the Projection.

The Demonstration you have universally in  
*Prop. 4.*

Or, since by (*Prop. 1.*)  $C a$ , and  $C b$ , will be the half Tangents of the Arks  $A O$ , and  $A L$  (for the Primitive Circle is right to the Eye at  $d$  :) Therefore to project such a lesser oblique Circle, you need only take the half Tangents of the Distance of each End of the Diameter of such a lesser Circle from the Point  $A$ , opposite to the Eye supposed at  $d$ ; and set them from the Centre  $C$ , and they will find the Points  $a$  and  $b$ , the Ends of the projected Diameter; and  $a b$  bisected, will give the Centre  $e$ .



*It is plain from what hath been proved in Proposition 10, that the Angle of the Radii of any two Circles is equal to the Angle of the Intersection of their Peripheries: And therefore if it were required to draw a great Circle through the Point  $a$ , which shall make any given Angle with the Circle  $A a d$ ;*

Set the Tangent of that Angle from  $g$ , the Centre of the Circle  $A a D$ , found by the making a Circle pass through the three Points  $A$ ,  $a$ , and  $D$ , and that shall find the Point  $f$ , the Centre of the Circle required.

COROLLARY.

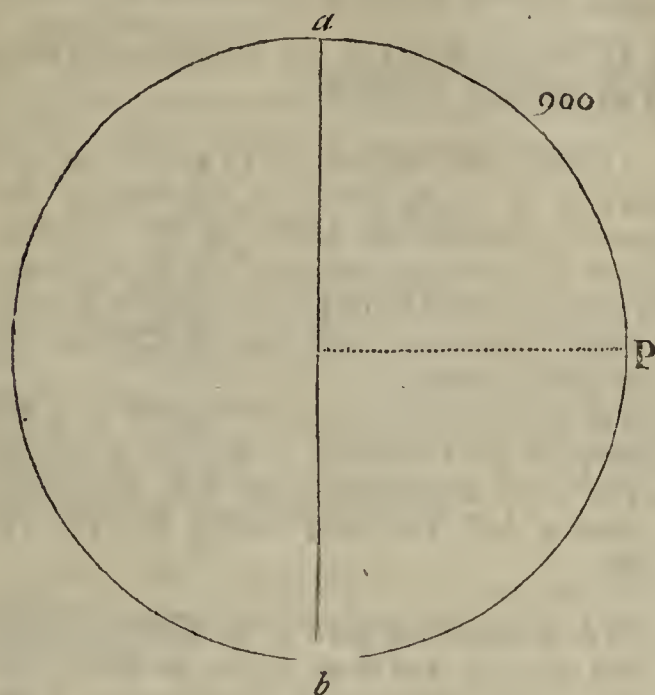
Hence, if  $a$  be supposed to be the Polar Point of the World projected, and it were required through it to project all the Hour-Circles,  $AaD$  will be the Hour-Circle of six, whose Centre is in  $g$ ; and by setting the Tangents of 15, 30, 45, 60, &c. both ways from  $g$  towards  $f$  and  $b$  (agreeable to the Radius  $ag$ ) all the other Hour-Circles may be described on the Plane of the *Projection* from their Centres in the Line  $fb$ .

Which is the Foundation of all *Dyalling*, or the *True Projection* of the *Hour-Circles of the Sphere* on any given Plane.



## P R O P. XIV.

Prob: 3. *To find the Pole of any Great Circle.*



If the *Pole* of *Primitive Circle* be required, 'tis its Centre.

If the *Pole* of a *Right* or *Perpendicular Circle* be sought, 'tis 90 Degrees distant, reckoned upon the Limb from the Points, where this Circle (which is a Diameter) cuts it.

As P is the *Pole* of the *Perpendicular Circle* *a b*.

If the *Pole* of an *Oblique Circle* be described, which in the Projection will be an Ark of a great Circle.

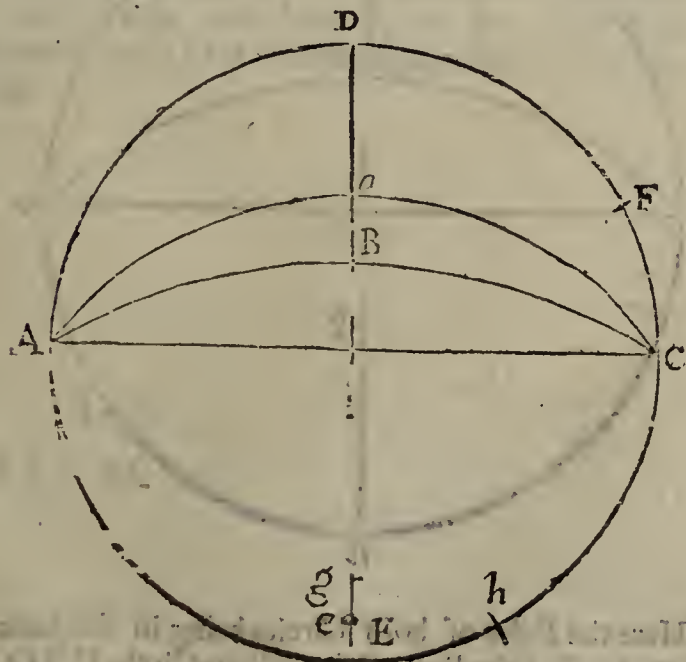
1. Consider that this Circle must cut the Primitive in two Points, that will be distant from each other just a Diameter, as is the Case of the Intersection of all great Circles.

2. The Pole of this Circle must be in a Line perpendicular to its Plane. And,

3. This Circle-Pole cannot but lie between the Centre of the Primitive one, and its own.

For Instance.

Let the Poles of the *Oblique Circle* *A B C* be required.



1. Draw the Diameter *A C*, and then another as *D E*, perpendicular to it.

2. Lay a Ruler from *A* to *B*, it will cut the Limb in *F*; then take the Chord of 90 Degrees, and set it from *F* to *b*.

3. Lay a Ruler from *b* to *A*, it will cut *D E* in *g*; which Point *g* is the Pole required.

*N. B.* The finding the Points *f* and *b*, is called reducing *B* to the *Primitive Circle*, and to the *Diameter*.

## P R O P. XV.

Problem 4. *To describe a Spherical Angle of any Number of Degrees given.*

1. If the Angular Point be at the Centre of the *Primitive Circle*, then 'tis made at any Plane Angle, numbring the Degrees in the Limb, from the Line of Chords: For all Circles passing thro' the Centre, and which are at right Angles with the Limb, must be projected into right Lines.

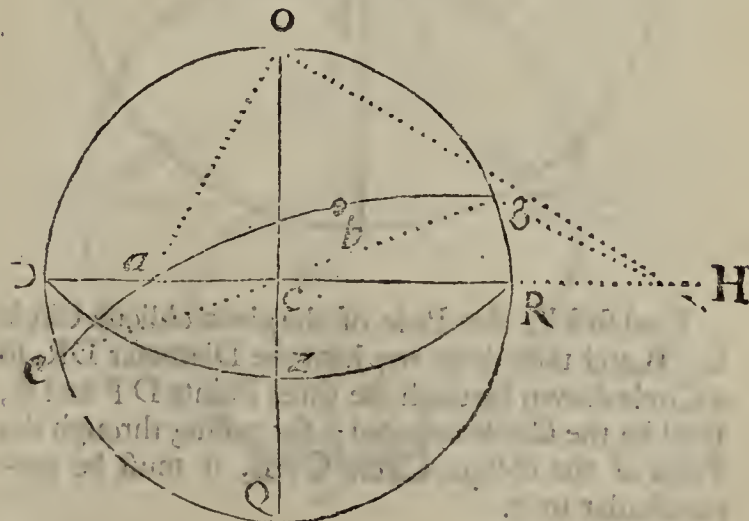
2. If the Angular Point be at the Periphery of the *Primitive Circle*, draw a Diameter, as *A C*; (see the last Figure): Then take the Secant of the Angle given in your Compasses (as suppose 65 Degrees) and setting one Foot in *A*, cross the Diameter in *e*, or if no Diameter be drawn, placing one Foot in *C*, and crossing the former Ark, you will find the same Point *e*, which is the Centre of the Circle *A a C*, which, with the *Primitive*, makes an Angle *D A a* of 65 Degrees.

*N. B.* If the Angle given be obtuse, take the Secant of its Supplement to 180 Degrees.

3. If a Point, as *a*, were assigned, thro' which the Ark of the Circle constituting the Angle must pass, draw the Diameter *A C* (as before): Then take the Secant of the given Angle, and setting one Foot in *A* or *C*, strike an Ark as at *e*, and then with the Secant of the given Angle, setting one Foot in *a*, cross the other Ark in *e*, which will be the Centre of the *Oblique Circle* required.

## P R O P. XVI.

Prob. 5. *To draw a great Circle thro' any two Points given, as a and b, within the Primitive one.*



Draw a Diameter thro' that Point which is furthest from the Centre, as *D R*, producing it beyond



yond the Limb, if there be occasion; set 90 Degrees from D or R to O, and draw O a.

Then erect O H perpendicularly to a O, and produce it 'till it cuts the Diameter prolonged in H; that Interfection H is a third Point, through which, as also this a and b, if a Circle be drawn, it will be a great Circle, as e a b g.

Which is easily proved, by drawing the Line e C g; for that Line is a Diameter: Because its Parts multiplied into one another, are equal to  $a c + c H = O C g$ , by 35 è 3, and Cor. 8 è 6, Euclid.

### P R O P. XVII.

Problem 6. To draw a great Circle perpendicular to, or at right Angles with another.

Let it pass through its Poles, and 'tis done.

Of which there will be four Cases.

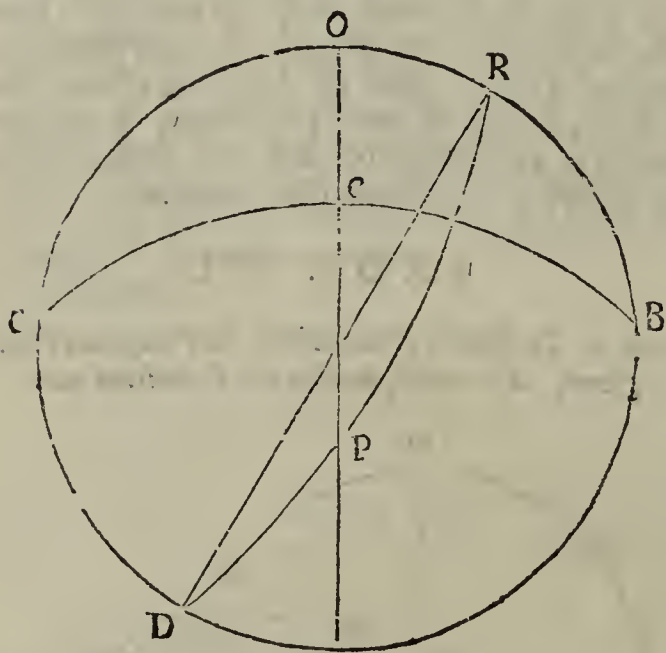
1. To draw a Circle perpendicular to the Primitive; which is done by any straight Line passing through the Centre.

2. To draw a Circle perpendicular to a right Circle, is only to draw a Diameter at right Angles with that right Circle.

3. To draw an oblique Circle perpendicular to a right one; only draw a Circle which shall pass through both the Poles of such a right Circle, and 'tis done.

Thus the oblique Circle D z R, is perpendicular to the right one O Q, because it passes through its Poles D and R. See the last Figure.

4. To draw one oblique Circle perpendicular to another.



Find first P, the Pole of the given oblique Circle C e B, and then draw any how the Diameter DR, so a Circle drawn through the three Points D P and R, shall be the Circle required; for passing through the Poles of the oblique Circle C e B, it must be perpendicular to it.

### P R O P. XVIII.

Problem 7. To measure the Quantity of the Degrees of any Ark of a great Circle.

1. If the Ark be part of the Primitive, 'tis measured on the Line of Chords.

2. If the Ark be any part of a right Circle, the Degrees of it are measured on the Scale of half Tangents, supposing the Centre of the Primitive Circle to be in the beginning of the Scale; so that if the Degrees are to be reckon'd from the Centre, you must account according to the Order of the Scale of half Tangents.

But if the Degrees are to be accounted from the Periphery of the Primitive, as will often happen, then you must begin to account from the End of the Scale of half Tangents, calling 80, 10, 70, 20, &c.

3. To measure any part of an Oblique Circle; first find its Pole, and there laying the Ruler, reduce the two Extremities of the Ark required to the Primitive Circle, and then measure the Distance between those Points on the Chords.

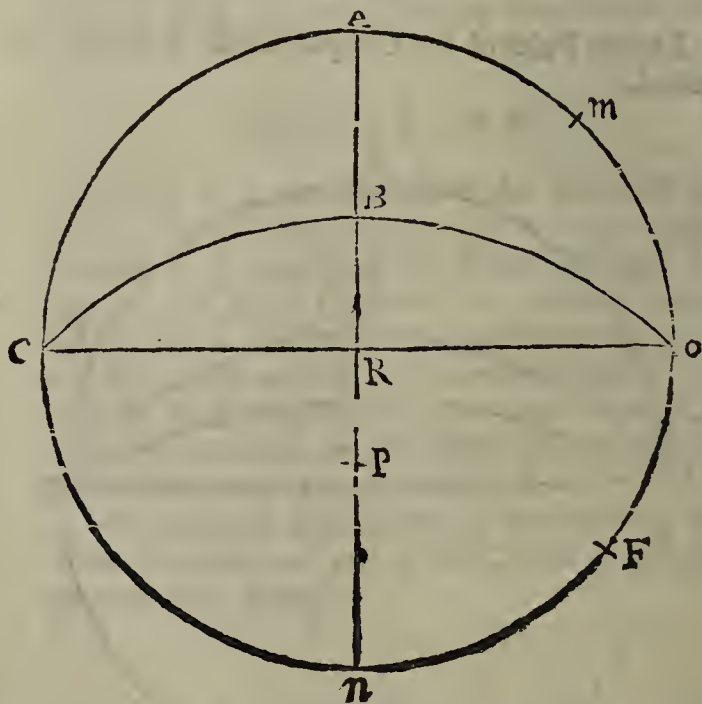
Thus in the last Figure, if the Quantity of e B, an Ark of the oblique Circle C e B were required; lay a Ruler to P, the Pole, and reduce the Points e and B to the Primitive Circle; so shall the Distance between o and B, measured on the Chords, be the Quantity of Degrees in the Ark e B.

### P R O P. XIX.

Problem 8. To measure any Spherical Angle.

1. If the Angular Point be at the Centre of the Primitive, then the Distance between the Legs taken from the Limb, and measured on the Chords, is the Quantity of the Angle.

2. If the Angular Point be at the Periphery of the Primitive Circle, as suppose the Angle A C B were required.



Here the Poles of both Circles being in the same Diameter, find the Pole of the oblique Circle C B O, which



which let be B P. Then the Distance R P, measured on the Scale of half Tangents, is the Measure of the Angle A C B.

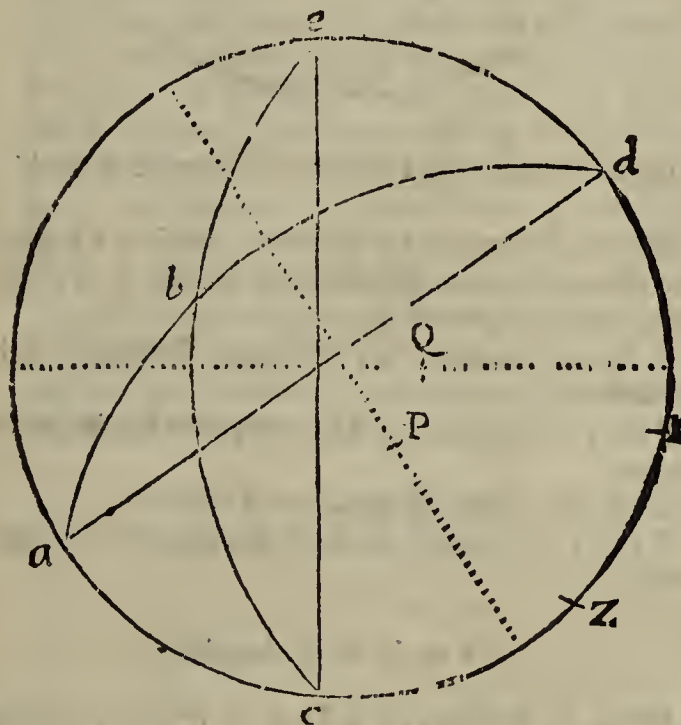
For the Poles of all Circles must be as far distant from each other, as is the Angle of the Inclination of their Planes.

But if the two Poles are not in the same Diameter, being both found in their proper Diameters, reduce those Points to the primitive Circle, and then the Distance between them there, accounted on the Chords, is the Quantity of the Angle sought.

Thus, if the Angle B C R be sought.

A Ruler laid to the Angular Point C, and P the Pole of the oblique Circle C B O, will find on the Limb of the Point F, and being laid from the same Angular Point through *n*, the Pole of the right Circle C R O, will give the Point *n* in the Limb; wherefore the Ark F *n* measured on the Chords, is the Measure of the Angle B C R.

3. When the Angular Point is somewhere within the primitive Circle, and yet not at the Centre, proceed thus:

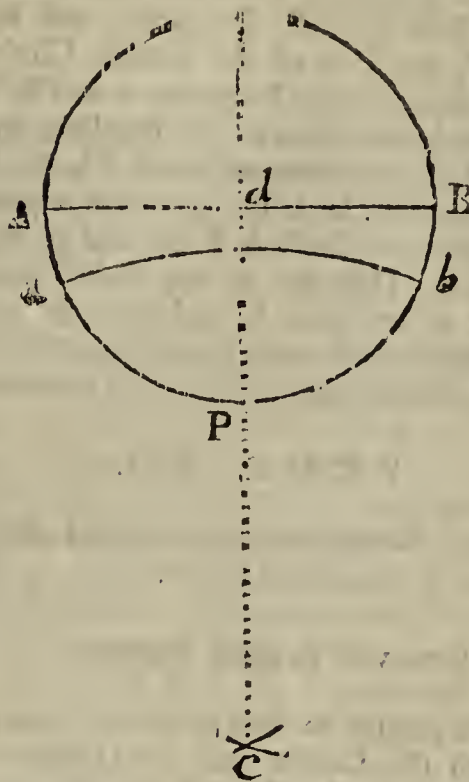


Suppose the Angle *a b c* be sought.

Find the Pole P of the Circle *a b d*, and then the Pole of the Circle *e b C*: After which lay a Ruler to the Angular Point; and the two Poles P and Q, and reduce them to the primitive Circle, by the Points *x* and *z*; so is the Ark *x z* measured on the Chords, the Measure of the Angle *a b c* required, and *C b d* is its Complement to 180 Degrees.

## P R O P. XX.

Problem 9. To draw a Parallel Circle.

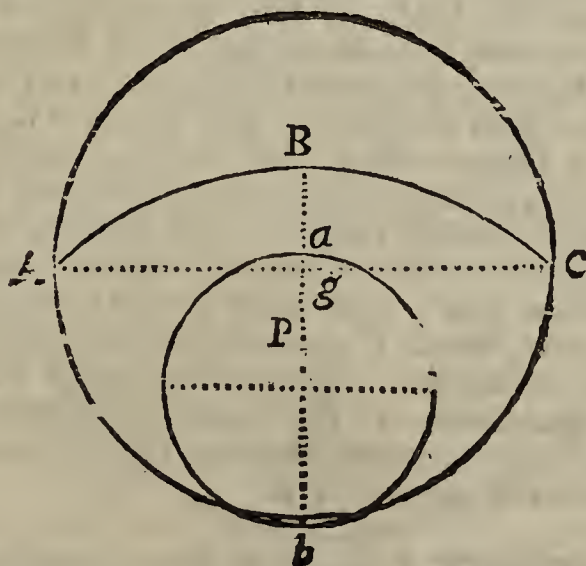


1. If it be to be drawn parallel to the primitive Circle at any given Distance, draw it from the Centre of the Primitive, with the Complement of that Distance taken from the Scale of the half Tangents.

2. If it be to be drawn parallel to a right Circle, as suppose *a b* parallel to A B, were to be drawn at 23 Degrees 30 Minutes distant from it; from the Chords take 23 Degrees 30 Minutes, and set it both ways on the Limb from A to *a*, and B to *b* (or set its Complement 66 Degrees 30 Minutes both ways from P the Pole of A B) to the Points *a* and *b*.

Then take the Tangents of the Parallel's Distance from the Pole of the right Circle A B, which is here 66 Degrees 30 Minutes, and setting one Foot in *a* and *b*, with the other strike two little Arches to intersect each other somewhere above P, which will give C, the Centre of the parallel Circle *a b d* required.

3. If it be to be drawn parallel to an oblique Circle, and at the Distance suppose of 40 Degrees.



First, find P the Pole of the oblique Circle A B C, and then measure on the Scale of half Tangents



gents the Distance  $g P$ , which suppose to be 34 Degrees, then add to it 50 Degrees, the Complement of the Circle's Distance, it will make 84 Degrees, and also subtracting 50 from it, or it from 50, it will make 16 Degrees: Then this Sum and Difference taken from the half Tangents, and set each way from  $P$ , the Pole of the oblique Circle, will give the Diameters two Extrems  $a$  and  $b$ , or the Points of the Intersection of the Parallel, and then the middle Distance between  $a$  and  $b$  is the Centre of the true parallel Circle  $P a b$ , which is parallel to the given oblique Circle  $A B C$ , and at the given Distance of 40 Degrees; or the half Tangent of 84 set from  $g$ , will give  $b$ , and the half Tangent of 16 Degrees set also from  $g$ , will give the Point  $a$ , the two Ends of the parallel Circle's Diameter.

PROP. XXI.

Problem 10. To measure any projected Arc<sub>b</sub> of a parallel Circle.

Here will be three Varieties.

1. If it be parallel to the Primitive, then a Ruler laid through the Centre and the Division of the Limb, will divide the Parallel into the same Degrees, or determine in the Limb the Quantity of any Ark parallel to it.

2. If the Circle be parallel to a right one, as *a b d* is, in case the second of the last Proposition, and it were required to measure that Ark *a b*, or to divide it into proper Degrees: Since that parallel Circle is 66 Degrees, 30 Minutes distant from P, the nearer Pole of the right Circle A B, and consequently 113 Degrees, 30 Minutes distant from its other Pole, take the half Tangent of 113 Degrees, 30 Minutes, or the Tangent of its half 56 Degrees, 45 Minutes, and with that Distance, and on the Centre of the Primitive, draw a Circle parallel to the Limb, and divide that half of it which lies towards the opposite Pole of A B into its Degrees, which is easily done by a Sector: Then a Ruler laid from P, and the equal Divisions of that Semicircle shall divide *a b*, or measure any Part of it.

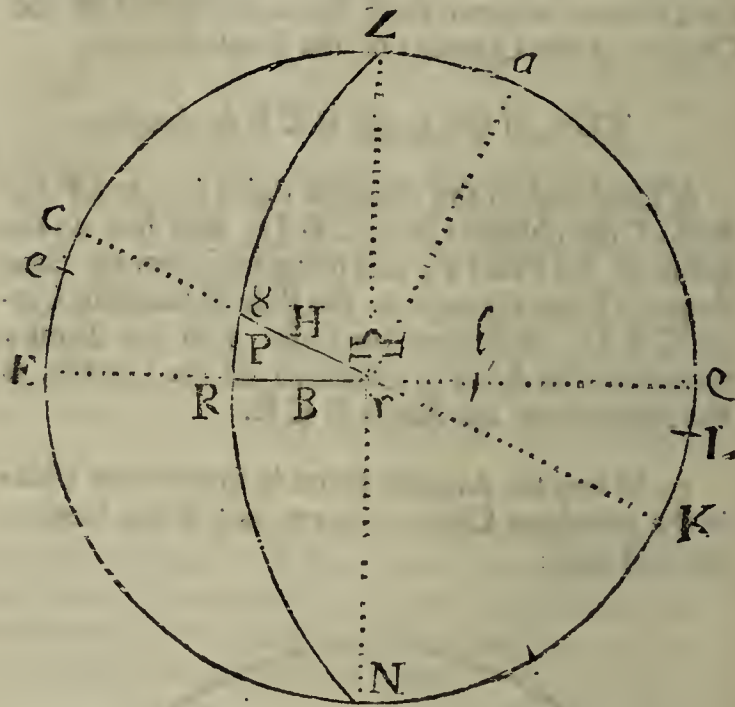
3. To measure or divide the Ark of a Circle, which is projected parallel to an oblique one.

As suppose the Circle  $ab$ , which is parallel to the oblique one  $ABC$ , in case the third (*Fig. 2.*) of the preceding Proposition, and at the Distance of 40 Degrees; this parallel Circle being 40 Degrees distant from the Plane of the Circle  $ABC$ , must be 50 Degrees distant from its Pole, and consequently 130 Degrees from the opposite Pole. Take therefore the half Tangent of 130 Degrees, or the Tangent of its half 65 Degrees, and with that, as a Radius, draw a Circle parallel to the Limb of the Primitive, which Circle divide it into proper Degrees: Then shall a Ruler be laid through  $P$ , and the equal Division of that Circle cut the little Circle  $ab$  into its proper Degrees, or truly give the Measure of any Part of it.

SPHERICK *Triangle*, is a Space included within the Arks of three great Circles of the Sphere, intersecting each other on the Surface of the Globe; and every such Triangle is either *Quadrantal*, which

hath on one Side (at least) a Quadrant and one Angle right; or *non Quadrantal*, which hath all its Sides more or less than 90 Degrees, and all its Angles bigger or lesser than right ones.

*The Application of Spherick Geometry, to the  
Construction and Mensuration of all the Parts of  
Spherick Triangles.*



In the Right-angled Spherick Triangle  $\gamma$  R  $\delta$ .

H = 54 Degrees, 15 Minutes, the Sun's Longitude from the next Equinoctial Point, or 24 Degrees, 15 Minutes of  $\delta$ .

B = 51 Degrees, 52 Minutes, the Sun's right  
Ascension.

P = 18 Degrees, 15 Minutes, the Sun's Declination.

$\delta$  = the Angle of the Sun's Position.

$\gamma$ ,  $\ominus$ , the Angle of the Sun's greatest Declination.

*To make the Triangle.*

With 60 Degrees of a Line of Chords, describe the Circle  $ZCKQ$ , which is the Limb, or Primitive Circle, and here represents the Solstitial Colure. Draw the Diameter  $EQ$ , which will be the Equator  $g$ , here represented by a right Line, because the Eye is at  $\gamma$  or  $\ominus$ , in its Plane. Take 23 Degrees, 30 Minutes from the same Chord, and set it from  $E$  to  $C$ , so shall  $CK$  be the Ecliptick, which will be a right Line also for the same Reason. Then either the Sun's Place set from  $\gamma$  on the Ecliptick, or his right Ascension set from thence on the Equator, will give the Point  $\delta$ , or  $R$ , accordingly. Then draw  $ZN$  at right Angles to the Equator, and so you will have three Points  $Z \delta N$ , or  $ZRN$ , through which the Circle of Declination  $Z \delta RN$  may be easily drawn.

*To measure the Sides and Angles.*

The Sides H and B being streight Lines, are measured on the Scale of half Tangents, by *Prop. 6.* of *Spherick Geometry*; and the Side P is measured by finding *l*, the Pole of the oblique Circle Z  $\propto$  H; and from thence laying a Ruler to the two Extremities of the Side P (*i. e.*) through  $\propto$  and R, in order to reduce them to the Limb in E and *e*; the  
Ark



Ark Ee, measured on the same Line of Chords, will give the Quantity of the Side  $\propto$  R = 18 Degrees, 15 Minutes.

And this is the general Rule to measure the Arks  
of all oblique Circles, *Prop. 18. Case 3.*

*For the Angles.*

That at R is a right one, and so known.

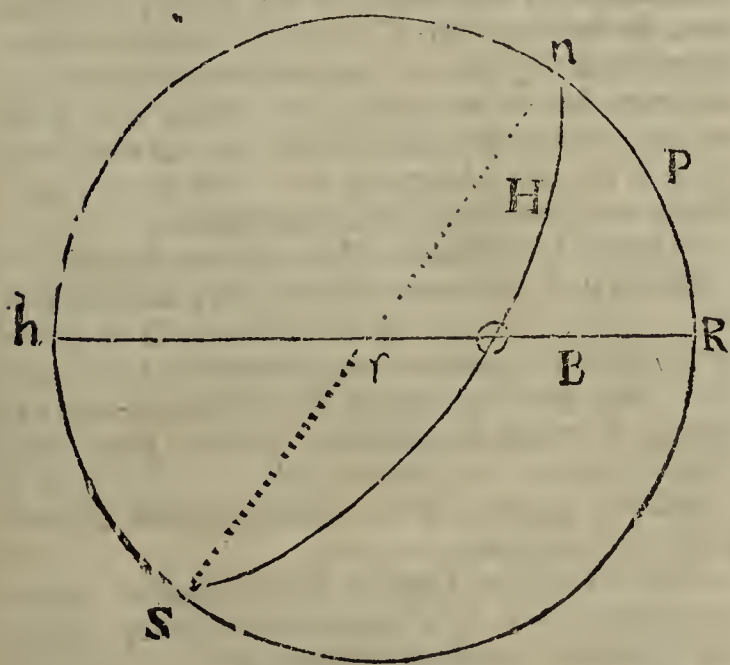
That at  $\mathcal{V}$ , is the Angle of the Sun's greatest Declination = 23 Degrees, 30 Minutes, and its Measure is the Ark E C of the Limb, by *Prop. 19. Numb. 1.*

The Angle of the Sun's Position  $\angle$ , is measured by laying a Ruler through  $\angle$ , the Angular Point, and through  $a$  and  $l$ , the Poles of the Circles  $C \gamma K$ , and  $N \delta Z$ , which will find the Points  $a$  and  $L$  in the Limb, and the Ark  $aL = 72$  Degrees is the Measure of the Angle  $\angle$  required, by *Prop. 19. Numb. 3.*

You may confider alfo, the Triangle  $Z C \delta$ , where one Angle is at the Periphery of the primitive Circle, and this will help to fhew the Variety of Right-angled *Spherick Triangles*.

Here the Angle  $C$  is a right one, being made by an Hour-Circle, or the Meridians cutting the Equator; for here  $CK$  may represent the Equator; and let  $Z$  be the Zenith of any Place, then will  $C$  be the Hour from Noon;  $CZ$  will be the Latitude of the Place, and  $\angle Z$  the Complement of the Sun's Height, being now supposed to be in the Equator. The Angle  $Z$  will be the Sun's Azimuth from the South, the oblique Circle  $Z \angle R N$  being a Vertical one; and the Angle  $\angle$ , will be the Angle of the Sun's Position. Which Triangle  $C \angle Z$  may be formed, and all its Sides and Angles measured by the Propositions and Rules above delivered.

Again,



In the Right-angled Spherick Triangle N  $\odot$  R.

R = right Angle made between the Horizon  
H R, and the Meridian  $n$  R.

B = Complement of the Sun's Amplitude = 50  
Degrees, 8 Minutes.

H = to the Sun's Distance from the Pole above the Horizon  $b R$ ; or the Complement of his Declination.

P = to the Elevation of the Pole, or Latitude of the Place.

☉ = the Angle of the Sun's Position.

⊙  $n$  R = the Hour from Midnight.

*To describe this Triangle.*

First draw the Circle  $h n R$ , representing the Meridian, and then the Diameter  $h R$  for the Horizon of *London*: Set the Pole's Height 51 Degrees 30 Minutes from  $R$  to  $n$  the North-Pole, and draw the obscure Axis  $n \gamma S$ . Then if the Sun's Amplitude be given, set that. Suppose 39 Degrees 52 Minutes from  $\gamma$  to  $\odot$ , which will limit the Base  $B$ , and give a Point through which and the two other given Points  $n$  and  $S$ , a great Circle may be drawn, which will form the Triangle. But if instead of that, the Angle  $\odot n R$ , or the Time from Midnight had been given, then you must turn that time into Degrees, and by *Prop. 15*. *Case 2.* make a Spherick Angle with the Limb of that Number of Degrees at the Point  $n$ , and that will determine the Point  $\odot$ .

The Angle  $\odot n R$ , is measured by *Prop. 19.*  
*Case 2.*

*Thus also in Oblique-angled Spherick Triangles, all the Sides and Angles may (by this Method) be measured, and the Triangles constructed.*

In the following Obtuse-angled Spherick Tri-  
angle  $\odot Z N$ .

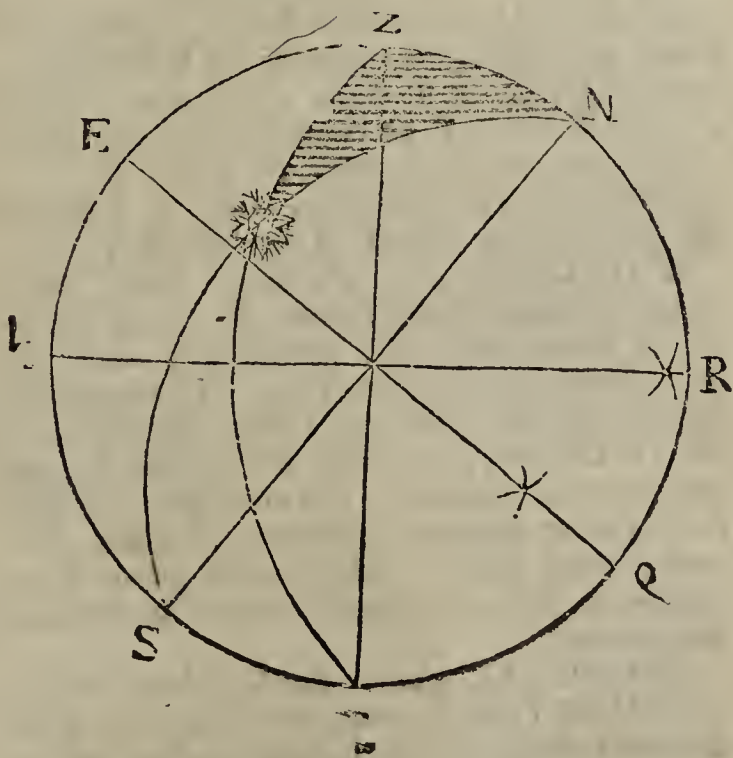
**ZN** = to the Complement of the Pole's Elevation, = 38 Degrees, 30 Minutes.

⊙ N = the Complement of the Sun's Declination from the Equator E Q.

⊙ Z = 46 Degrees, 49 Minutes = the Complement of the Sun's Altitude above the Horizon  
b R.

☉ N Z = 30 Degrees, is the Hour from Noon,  
or Ten a Clock in the Morning.

☉ ZN = 137 Degrees, 47 Minutes, is the Sun's Azimuth from ZR<sub>n</sub>, the North Part of the Meridian.





*To Construct the Triangle.*

1. With 60 Degrees of a Line of Chords draw the primitive Circle *Z R n b*, which crosses in the Centre with two Diameters *b R*, representing the Horizon of *London*, and *Z N* the prime Vertical Circle.

2. Set the Elevation of the Pole = 51 Degrees, 30 Minutes, from *R* to *N*; so is *N* the North Pole of the World: And drawing *N S* through the Centre, it will be the Axis, and *S* the South-Pole.

3. Cross *N S* with another Diameter at right Angles, and that will be *E Q*, the Equinoctial.

4. Then because the Time from Noon is 2 Hours, or 30 Degrees, and that all Hour-Circles pass through the Poles, and make Angles with the Meridian, make an Angle at *N*, of 30 Degrees, by *Prop. 15. Case 2.* which will be the Spherick Angle *E N D*.

5. And since the Azimuth is 137 Degrees, 47 Minutes from the North, subtract that out of 180, and there will remain 42 Degrees, 13 Minutes, the Sun's Azimuth from the South; and because all Azimuths, or Vertical Circles, pass through *Z* the Zenith, make an Angle with the Primitive at *Z*, of 42 Degrees, 13 Minutes (by *Prop. 19. Case 2.*) and so will your Triangle be Stereographically projected, and the Reason of the Thing made plain and easy.

I don't give Instances of the *Analemma*, or of the several Stereographick Projections on the Planes of the Horizon, Equator, Meridian, &c. because you will find them in their proper Places under those Words.

**SPHERICAL Astronomy**, that Part of Astronomy which considers the Universe as it appears to the Eye.

**SPHERICAL Numbers.** See *Circular Numbers*.

**SPHERICITY**, the Quality of a Sphere, or that by which a Body becomes Spherical.

**SPHEROID**, [of *σφαῖρα* a Sphere, and *ἵδω*, Gr. Shape] is a solid Figure made by the Rotation of a *Semi-Ellipsis* about its Axis, and is always equal to two Thirds of its circumscribing Cylinder, *Archim. de Conoid & Spheroid. 18. & 25. 2.*

**SPHINCTER**, [*σφιγκτηρ*, Gr.] is a Muscle that contracts the Gullet, Anus, Bladder, &c.

**SPHINCTER Ani**, is a large, thick, fleshy Muscle, encompassing the *Anus*: Its Figure and Series of Fibres externally, immediately under the Skin, incline to an oblong Oval: It is connected forward to the *Accelerator Urinæ*, backwards to the *Os Coccygis*; its Fibres are circular for near two Inches in Breadth: It is much larger in Men than in other Animals, in whom, by reason of the erect Position of the Body, there is greater Force required to retain the *Fæces*, which is the Office of this Muscle.

**SPHINCTER Gulæ.** See *Oesophagus Gulæ*.

**SPHINCTER Vaginæ**, is a Muscle lying immediately under the *Clitoris*, encompassing the *Vagina* with circular Fibres three Fingers in Breadth.

In some Subjects (saith Mr. *Cowper*) it scarce appeareth fleshy. When this Muscle acts, it not only straightens the *Vagina*, but thereby it also hinders the Blood in its Return from the *Plexus retiformis* of the *Pudendum*, by compressing some of its Veins that pass underneath, by which means the *Labia* become distended, and the *Vagina* contracted.

**SPHINCTER Vesicæ**, is a Muscle seated in the upper Part of the Neck of the Bladder, immediately above the *Glandula Prostatæ*, whose Contraction hinders the Involuntary Egress of the Urine.

**SPHYGMICA**, [of *σφυγμῶς*, Gr. the Pulse] is that Part of Physick which treats of Pulses. *Blanchard*.

**SPIKES**, or, as the Seamen call them, *Speeks*, are large long Iron Nails with flat Heads; they are of diverse Lengths, some a Foot or two long, and some are jagged, so that they cannot be drawn out again. They are used to fasten Planks and Timbers. They call also a kind of small *Fidd*, which serves them to open and splice small Ropes, a *Marling Spike*.

**SPIKING up the Ordnance**, is fastning a *Coin*, or *Quoin*, with *Spikes* to the Deck, close to the Breech of the Carriages of the Great Guns, that they may keep close and firm to the Ship's Sides, and not break loose when the Ship rolls, and by that means endanger the breaking out of the *Butthead* of a Plank.

**SPINA Dorfi**, are the hinder Prominences of the *Vertebrae*.

**SPINA Ventosa**, is an Ulceration, in which the Bones are eaten by a malignant Humour without any Pain of the *Periostium*, or Membrane that covers the Bone: After that, a Swelling being risen without any Pain, the Part affected is quite eaten out with the Ulcer, from whence frequently follows a Necessity of Amputation.

**SPINALIS Colli**, is a Muscle so called, because it accompanies the Spines of the Neck; it arises from the five superior Transverse Processes of the *Vertebrae* of the *Thorax*, and inferior of the Neck, and in its Ascent becomes more fleshy, and is so largely inserted into the inferior Part of the *Vertebrae* of the Neck laterally, &c. These draw the *Vertebrae* of the Neck directly backwards.

**SPINALIS Medulla.** See *Medulla Spinalis*.

**SPINDLE**, is the smallest Part of a Ship's Capstan, which is betwixt the two Decks. The *Spindle* of the *Jeer-Capstan* hath *Whelps* to heave the *Viol*. Also the Axis of the Wheel of a Watch or Clock, is called the *Spindle*, and its Ends the *Pevets*.

**SPINE**, the Back-Bone; or long-jointed Chinese-Bone that goes down the Back.

**SPINSTER**, a Term in Law, being an Addition usually given to all unmarried Women, from the Viscount's Daughter downward.

**SPIRAL**, in *Architecture*, &c. is a Curve that ascends winding about a Cone, or Spire, so that all the Points thereof continually approach the Axis; and by this it is distinguished from the *Helix*, which winds after the same manner round a Cylinder.

**SPIRAL-Line**, in *Geometry*, is, according to *Archimedes*, thus generated.

If a right Line, as *A B*, having one End fix'd at *B*, be equally moved round, so as with the other End *B*, to describe the Periphery of a Circle, and at the same time a Point be conceived to move forward



forward equally from B towards A in the right Line B A, so as that the Point describes that Line, while the Line generates the Circle. Then will the Point with its two Motions describe the Curve Line B, 1, 2, 3, 4, 5, &c.



which is called an *Helix*, or Spiral Line; and the plane Space contained between the Spiral Line, and the Right Line B A, is called the *Spiral Space*.

If also you conceive the Point B to move twice as slow as the Line A B, so as that it shall get but half way along B A, when that Line shall have formed the Circle; and if then you imagine a new Revolution to be made of the Line carrying the Point, so that they shall end their Motion at last together; there will be formed a *Double Spiral Line*, and two Spiral Spaces, as you see in the Figure. From the Genesis of which may easily be drawn these Corollaries.

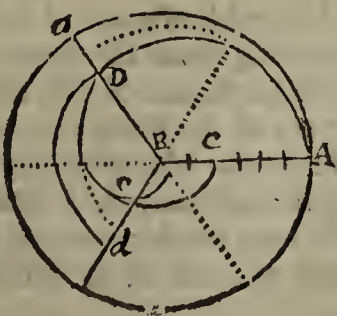
1. That the Lines B 12, B 11, B 10, &c. making equal Angles with the first and second Spiral, (as also B 12, B 10, B 8, &c.) are in Arithmetical Proportion.

2. The Lines B 7, B 10, &c. drawn any how to the first Spiral, are to one another as the Arks of the Circle intercepted betwixt B A and those Lines. Because whatever Parts of the Circumference the Point A describes, as suppose 7, the Point B will also have run over seven Parts of the Line A B.

3. Any Lines drawn from B to the second Spiral as B 18, B 22, &c. are to each other as the afore-said Arks, together with the whole Periphery added on both Sides: For at the same time that the Point A runs over 12, or the whole Periphery, and perhaps seven Parts more shall that Point B have run over 12, and seven Parts of the Line A B, which is now supposed to be divided into twenty-four equal Parts.

### PROPOSITIONS.

I. The first Spiral Space A D c B is to the first Circle :: as 1 to 3.



Divide the Circumference of the Circle into three equal Parts by Lines drawn from the Centre B, beginning from the first Line B A; then will (by Cor. 1.) B c be = 1, B D = 2, and B A = 3; and the Sectors circumscribed about the Spiral will be as the Squares of the Radii, viz. C B c = 1, D B d = 4, and A B a = 9; and so it will be always, if you make never so many Bisections of the three first Divisions of the Circle; that is, the Lines drawn from B to the Spiral, will be as 1, 2, 3, 4, 5, 6, &c. and the Sectors circumscribed, as 1, 4, 25, 36, &c. always going on in the Order of Squares, or in a duplicate Ratio. But a Rank of such Terms, are to a Rank of as many, equal to the greatest, as 1 to 3 (by N. 7. of *Arithm. Progression*). Wherefore the whole Spiral Space (which is composed of such Sectors) is to the whole Circle :: as 1 to 3. Q. E. D.

Or,

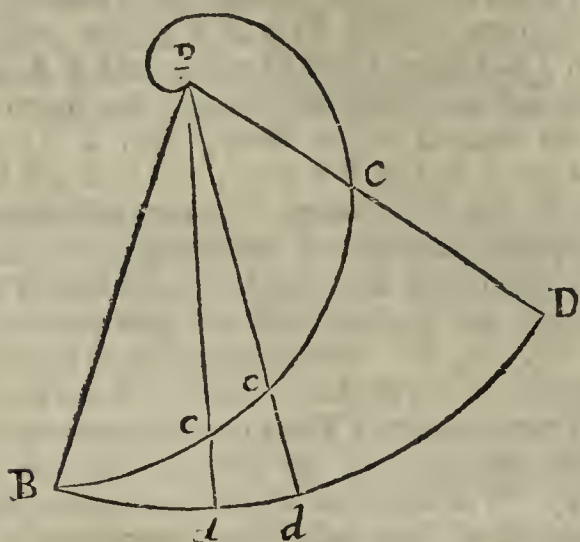
If another Circle be drawn with a Radius double to the former, its Area will be (as the Square of its Diameter) four times as great as that of the former. Therefore the first Circle to the second will be as 1 to 4, or as 3 to 12. And since the Spiral Space is to the first Circle as 1 to 3, that Space to the second Circle will be as 1 to 12; and to a third Circle so described, as 1 to 27; to a fourth, as 1 to 48, &c.

II. The first Spiral Line is equal to half the Periphery of the first Circle; for the Radii of the Sectors, and consequently the Arches are in simple Arithmetick Progression, while the Periphery of the Circle contains as many Arches equal to the greatest; wherefore the Periphery to all those Arches, is to the Spiral Line as 2 to 1 (by N. 6. of *Arithm. Progression*.)

I thought one Proposition, with a Corollary or two, enough on this Subject, to give the Reader a Specimen of the *Genesis, Nature and Properties*, and way of Demonstration used about *Spiral Lines*: Those that will see more, may consult *Archimedes*, *Dr. Wallis's Arithmetick of Infinites*, or *Sturmius's Math. Enucleat.* lib. 2. chap. 4.

*Proportional Spirals*, are such Spiral Lines as the Rhumb-Line on the Terrestrial Globe, which because they make equal Angles with every Meridian, must also (as we shew in *Prop. 7. of Spherick Geometry*, which see) make equal Angles with the Meridians in the Stereographick Projection on the Plane of the Equator; and therefore will be, as the learned Dr. Halley observes, *Proportional Spirals* about the Polar Point. From whence that excellent Mathematician demonstrates, that the Meridian-Line is a Scale of Log. Tangents of the half Meridian-Complements of the Latitudes. See *Meridian-Line*.





In *Proportional Spirals*, the Angles  $BPD$ ,  $BPd$ , &c. or the Arches  $BD$ ,  $Bd$ , &c. are *Exponents* of the *Ratio's* of  $BP$  to  $PC$ . For if the Arch  $BD$  be divided into innumerable equal Parts, right Lines drawn from them to the Centre  $P$ , shall divide the Curve  $BccC$  into an Infinity of Proportionals; and all the Lines  $Pc$ ,  $Pc$ , &c. shall be an Infinity of Proportionals between  $PB$  and  $BC$ , whose Number is equal to all the Points  $dd$ , in the Arch  $BD$ : But an infinite Number of Proportionals between the two Terms of the Ratio, is to that infinite Number of equal Parts between any other two Terms :: as the Logarithm of the one Ratio is to the Logarithm of the other; therefore, as  $BD$  to  $Bd$ , or as the Angle  $BPD$  to the Angle  $BPc$ ; so is the Logarithm of the Ratio of  $PB$  to  $PC$ , to the Logarithm of the Ratio of  $PB$  to  $Pc$ . Q. E. D.

**SPIRIT**, which the Chymists call *Mercury*, is one of the five Principles separable from a mix'd by Fire; 'tis subtil, light, penetrating, and active, and hath its Particles in a very quick Motion. This is probably that which causes the Growth and Increase of all Bodies; but where it abounds most, those Bodies do soonest corrupt, because of its rapid Motion. This appears in Vegetable and Animal Bodies, which yield the greatest Quantity of Spirit; whereas most Minerals, as having but a small Proportion of Spirit in them, are almost incorruptible.

This Principle is never drawn pure any more than the others; and when it comes over involved in a little Oil, 'tis call'd an ardent Spirit, such as Spirit of Wine, which therefore should rather be called an exalted Oil; and when it hath in it a little Volatile Salt dissolved, 'tis called a *Volatile Spirit*, as the Spirit of Hart's-horn, Urine, &c. If it be impregnated with acid Salts, its Volatility is then check'd, and 'tis called an *Acid* or *Fix'd Spirit*, as Spirit of Salt, Vitriol, Allum, &c. which truly are only an acid Salt dissolved and put into Fusion by a strong Fire.

**SPIRIT of Nitre** is thus drawn: Mix one Part of Salt-petre with three times as much Potter's-Earth dried; put this Mixture into a large earthen Retort, and set it in a close Reverberatory Fire; distil off the Phlegm with a small Fire in about four or five Hours, and when no more Drops will come, lute on a very large Receiver, and encrease the Fire gradually to the second Degree, some more volatile Spirits will come out in white Clouds: Keep the Fire thus about two Hours, and then increase it to the greatest Violence you can give it, the Va-

pours will come red; continue the Fire 'till no more red Fumes come; in fourteen Hours the Operation will be over. If you used two Pounds of Nitre, you will draw one Pound fourteen Ounces of Phlegm and Spirit together. The Vessels had need be large, and one Third of the Retort left empty, else there will be danger of breaking all to Pieces, the Spirits come forth with that Violence.

This Spirit is the best *Aqua-fortis*, and is chiefly used for Solution of Metals. But when dulcified, is a good Medicine inwardly in many Cases.

**SPIRIT of Salt**, is made by drying and powdering the Salt, and then mixing it with thrice its Weight of Potter's-Earth powder'd: A Paste is made of these two with a little Rain-water, and then the Paste is made into little Balls, or Pellets, about as big as Nuts. A large earthen Retort, or Glass one coated, hath one third of it filled with these, and being placed in a Reverberatory Fire, hath a large Receiver fitted to it. The Junctures must not be luted at first, but a very moderate Fire used for a time, to distil out all the Water: But as soon as you see some little white Clouds appear, throw out the insipid Liquor in the Receiver, and lute it well to the Retort: Then increase the Fire by degrees to the highest, and so let it continue twelve or fifteen Hours, or 'till no more Clouds appear; when the Operation is ended, you will find the Spirit of Salt in the Receiver. Some rectify this Spirit afterwards in a Cucurbit, by drawing off some of the weaker Spirit in a gentle Sand-heat, and then what remains is very strong, of a yellow Colour, and very weighty.

If equal Parts of this acid Spirit, and Spirit of Wine, are mixed together, and digested for about three or four Days, 'tis called *Spirit of Salt dulcified*.

Spirit of Salt will dissolve Leaf-Gold, and will precipitate what *Aqua-fortis* hath dissolved. Which shews how very differently formed and figured the Point and Pores of *Acid Menstruums* may be, and frequently are.

**SPIRIT of Sulphur**, commonly call'd Oil of Sulphur, *per Campanam* (from the Vessel's Form being like a Glass Bell, in which it is usually drawn) is only the acid Part of Sulphur turned into a Liquor by the means of Fire. Lemery uses a great Glass Tunnel for this Operation; which seems to be the best way of drawing this Spirit, *vid.* p. 445, *last Edition*. Some make use of Salt-petre in the drawing off Spirit of Sulphur, but that is not a good Practice, because the Nitre alters something of the Mixture of the Spirit.

**SPIRITS in an Animal Body**, were reckoned of three sorts; the Animal Spirits in the Brain, the Vital in the Heart, the Natural in the Liver: But late Authors distinguish 'em only into two Kinds; the Animal in the Brain, the Vital and Natural (which are accounted the same) in the Mass of Blood. The Animal Spirits are a very thin Liquor, which distilling from the Blood in the outward, or cortical Substance of the Brain, are by the proper Ferment of the Brain exalted into Spirit, and thence through the Medullar Substance of the Brain, the *Corpus Callosum*, and *Medulla Obion-gata*, are deriv'd into the Nerves and Spinal Marrow, and in them perform all the Actions of Sense and Motion.



The Vital or Natural Spirits are the subtlest Parts of the Blood, which actuate and ferment it, and make it fit for Nourishment.

SPLANCHNICA, are Medicines proper against Diseases of the Intestines.

SPLANCHNOLOGY [*σπλάγχχνολογία*, of *σπλάγχχνον*, the Bowels, and *λόγος*, Gr. Word, or Speech] a Discourse or Explication of the Viscera.

SPLEN, *sive* Lien, the Spleen, is a Receptacle for the salt and earthy Excrements of the Blood, that there, by the Assistance of the Animal Spirits, it may be volatiliz'd, and returning again into the Blood, may concur to its farther Fermentation. The Spleen consists of a great Number of little Bladders, between which the Glandules are scatter'd up and down, and supply the Place of Veins. The Spleen has likewise an Artery, Nerves, and Lymphatick Vessels, first discover'd by *Fr. Ruisch*, says *Blanchard*. But you will find a much better Account of it in *Gibson's Anatomy*, pag. 106. See Vol. II.

SPLENA, are Bolsters made of Linnen, three, four or five times doubled, even to the Thickness of the Spleen: They are used upon Wounds, Ulcers and Fractures. The Figure is threefold, according to the manner of Application, *viz.* at Length, Obliquely, or Transversely: They are called also *Plumaceoli*, and *Plagulæ*. *Blanchard*.

SPLENETICK Artery, is said by some to be the greatest Branch of the *Cœliaca*, whence it goes to the Spleen, and therein ends.

SPLENII Musculi, arise partly from the five lower *Vertebræ* of the Neck; and partly from the Points of five of the upper *Vertebræ* of the *Thorax*: The Fibres of these Muscles tend obliquely, and are fastened to the hinder Part of the Head. The use of them is to draw the Head backward. It hath its Name from its Figure, being something like to an Ox's Spleen.

SPLICE. At Sea they say a Cable, or Rope, is *spliced*, when the Ends of two Pieces being untwisted, the several Strands are wrought into one another by a Fidd. Also when an Eye is to be made at the End of a Rope, the Ends of the Strands are by a Fidd drawn into the Ends of the other Ropes Strands; and this is called a *Splice*.

SPLIT. The Seamen say, when a Sail is blown to Pieces, it's split.

SPOLIATION, is a Writ that lies for one Incumbent against another, in any Case where the Right of the Patronage cometh not in Debate: As if a Parson be made a Bishop, and hath Dispensation to keep his Rectory, and afterwards the Patron present another to the Church, which is Instituted and Inducted; the Bishop shall have against this Incumbent, a Writ of *Spoliation* in Court *Christian*.

SPONDÆUS, is the Foot of a Latin Verse, consisting of two Syllables, and both of them long, as *Ingens*.

SPONGIOSA, in Anatomy, Spongy, an Epithet given to several Parts of the Body from their Texture, which is porous and cavernous; as *Spongiosa corpora penis*, &c.

SPONGOEIDEA *offa*. See *Cribriformia*.

SPOONING, when a Ship being under Sail in a Storm at Sea, cannot bear it, but is forced to put right before the Wind; then the Seamen say, *she Spoons*; and when in such a Case there is Danger lest she should bring her Masts by the Board with

her rolling about, or Seel under Water, and so Founder, they usually set up the Fore-sail, to make her go the steadier, especially if there be Sea-room enough; and this they call *Spooning with the Fore-sail*.

SPORADICI Morbi [of *σποράδες*, Gr.] are those Diseases which (though different in Nature) seize several People at the same time, and in the same Country.

SPOTS in the Sun. Besides what may be concluded about these Solar Spots, being no Planets revolving round the Sun's Body, as some have thought, *Dr. Hook*, in his *Opera Post.* draws these further Conclusions: 1. That these Bodies are either opake, and so hinder the Sun's Light from passing through them, or else are incombustible and dark Bodies, which will afford no Light at all for a certain time, and do, as it were, quench and deaden that Part of the Sun where they rise. 2. There appear in some Parts of the Sun's Face also *Nebulæ*, or Clouds; in some others *Faculæ*, or Blazes, which give a clearer Light than the other Parts of his Body. The Spots are subject to increase and decrease, having sometimes covered a Part of the Sun bigger than all *Europe*, and sometimes bigger than the whole Surface of the Earth. 3. The Motion of these Spots is always from *East* to *West*, according to the Order of a Line of Sines, beginning from the Centre, of which the Semi-diameter of the Sun is Radius. And this Motion appears to be in a straight Line in the beginning of *June* and *December*, when the Earth is in that part of the Plane of the Ecliptick, which cuts the Plane of the Equinoctial of the Sun's turbinated Motion. At other times the Line of their Motion is incurvated and bent into an Ellipsis; which is greatest when the Earth happens to be in those Parts of the Ecliptick, which are the extreme Limits of it, compared to the Plane of the Sun's Equinoctial: And this also is twice a Year, *viz.* in the middle between the Nodes, both Planes passing through the Centre of the Sun, that is, about the beginning of *March* and *September*. Whence he deduces, by undeniable Demonstration, that the Sun is of a Globular Figure, and that it moves on its own Axis from *East* and *West*: As also, that the Axis of his turbinated Motion remains fixed, and is always directed towards the same Point in the Heavens, as the Earth's Axis is found to do; as also the Axis of *Jupiter* and *Saturn* is, as far as can yet be discovered by the Spots, Satellites, and Ring of these Planets. 4. He observes also, that there is a kind of Torrid Zone, or certain Space or Breadth on each Side the Sun's Equator towards the Poles, in which these *Maculæ*, *Nebulæ* and *Faculæ*, do appear most. Whereas, without these Limits, or in the Temperate Zones (as with Regard to our Earth they may be called) they appear but seldom, and never towards the Polar Parts.

SPOTS in the Sun. 'Tis certain those opake Masses which sometimes appear at the Sun, are not Planets revolving at any, even the least Distance from him, but *Spots*, or *Maculæ*, adhering to him; for whereas they revolve but once in about 26 Days, on Calculation it will appear, that a Planet near the Sun's Surface, as these must be, cannot have above three Hours allowed for its periodical Revolution, which being so different from the fore-mention'd Space of twenty-six Days, quite decides that Controversy, and demonstrates those Masses



to be real *Maculae* adhering to the Body of the Sun, as is here asserted.

Anno 1660, April 27th, 8 H. A. M. the Honourable Mr. Boyle observed a *Spot* in the lower Limb of the Sun, a little towards the South of its Equator, which was entred about  $\frac{1}{4}$  of the Sun's Diameter, it self being about  $\frac{1}{16}$  in its shortest Diameter of that of the Sun, its longest about  $\frac{1}{4}$  of the same.

May the 8th, about 10 in the Morning, it appeared near about the same Distance from the Westward Limb, a little South of its Equator; though at first it appeared to be from the Eastward Limb, a little South also of its Equator. May the 9th, it disappeared. The *Spot* was very dark, and almost of a quadrangular Form, and was enclosed round with a kind of dusky Cloud.

May the 25th the same *Spot* appear'd again, and seemed to be in a Part of the same Line it had formerly traced, and was entred about  $\frac{1}{3}$  of its Diameter, about 7 H. P. M. At which time there appear'd another *Spot*, which upon its Entrance was not above  $\frac{1}{13}$  Part of the Sun's Diameter: It appear'd to be longest towards the North and South, and shortest towards the East and West; and there seemed to be dispersed about it diverse small Clouds here and there.

Anno 1671, August the 11th, 6 H. P. M. Mr. Cassini, by the Help of a three Foot Glass, observed in the Sun's Disk two *Spots* very dark, and distant from his apparent Centre about  $\frac{1}{3}$  of his Semidiameter.

But, that he might the more exactly note their Situation, in respect of the several Parts of the World, he made use of two very fine Threads, cutting one another at Right Angles in the common Focus of the two Glasses, and in the Axis of the Telescope; so that he might see the Sun's Centre, and according as one of these Threads advanced Westward, it mark'd in the Sun a Circle parallel to the Equator; and the other Thread marked the Circle of Declination, or the *Horary Circle*. Then he observed that the *Spots* were in the Southern Part of the Sun; that their Elongation from this Parallel, passing through his Centre, could be no more than about  $\frac{1}{16}$  of his Diameter; and that they were situated on the Eastern Side in respect of the said Centre of the Sun. He also measured several times, from 6 o'Clock at Night to 7, the Time which lapsed between the Passage of the Sun's Centre, and that of the first of these *Spots*, through the said *Horary Circle*, which sometimes he found to be 23, sometimes 22 Seconds, the Semidiameter of the Sun then passing in 66 Seconds.

August the 12th, he observed them from the Time of Sun-rising, and perceived that now they were nearer his Centre. The Time between the Passage of the Sun's Centre, and that of the interior Edge of the Coronet which encompassed them both, was then of 16 Seconds. At 7 a Clock it was but of 15, and the Southern Limb of the Coronet touched the Parallel passing through the Sun's Centre.

From 6 at Night unto 7, the Time between the Passage of the Sun's Centre, and that of the Coronet's Limb, was found to be one time of 8 Seconds, at another time of 7 Seconds, and another of 7 Seconds and a half. The Distance of the *Spots* unto the Parallel, passing through the Sun's Centre, was near the same on the North Side with what it had

been observed to be in the Morning on the South Side.

August the 13th, about 6 in the Morning, the Edge of the Coronet was distant from the Equator, on the North Side, 30 Seconds; and there was but one Second of Time from the Passage of the Sun's Centre into the Passage of the same anterior Edge of the Coronet.

At 8 H. 30 Seconds, the Fore Edge was in the same *Horary Circle* with the Sun's Centre; so that in one Day and a half these *Spots* have run through very near the third Part of the Sun's apparent Semidiameter, which giveth an Arch of 19 Degr. 30 Min. of the Circumference of the Sun's Body; and consequently their Diurnal Motion about the Sun's Axis hath been of 13 Degr. and the Time of their Periodical Revolution, as far as could be conjectured in so little Time, must be about 27 Days and a half; which was confirmed afterwards by farther Observations. *Philos. Transf.*

August the 30th, 1671, Dr. Hook observed a large *Spot* in the Centre of the Sun's Face about Noon.

September the 1st, he saw the same *Spot* again, and observed it to be moved about a quarter of the Sun's Diameter Westward.

April the 25th, 1683, Mr. Flamsteed saw a large *Spot*, having 3 Minutes, 40 Seconds more North Declination than the Sun's Centre; and at 3 H. 35 Min. after Noon, he measured its Distance from the next Limb, 40 Seconds.

April the 26th, he saw it more remote from the Limb, and at 8 o'Clock determined its Longitude from the Sun's Axis  $66\frac{1}{2}$  Degr. and its Declination from the Solar Equator  $8\frac{2}{3}$  Degr. South.

The Revolution of this *Spot*, Mr. Flamsteed found to confirm his former Theory of the Sun's Motion round his Axis in 25 Days 6 Hours, and that the Angle of his Equator and our Ecliptick is 7 Degr. and the Longitude of his Northern Pole was in  $116$  Degrees.

SPRING of the Air, or its Elastic Force, see more in Air.

That there is such a Spring, or Elasticity in the Air, is clear from the following Experiments.

1. That Bladders but half blown up, and having their Necks well tied, did swell in the Exhausted Receiver as if blown to their full Dimensions; and that full blown Bladders, and even thin square Glass Vials well stopp'd, will break to Pieces when once the Air is well pump'd out of the Receiver.

2. A Glass Syphon, whose recurved Leg was turned up parallel to the upper and longer, and was sealed hermetically at the End of the lesser or shorter Leg, had a Quantity of Quicksilver poured into it, and by its being moved often up and down, the Air in the sealed and shorter Leg, was brought to the same Temperament of the External. After this more Mercury was poured in, till the Air in the sealed Leg was compressed into about half its usual Dimensions, and then the Mercury in the longer Leg was 29 Inches higher than that in the shorter: By which it appears plainly, that the Spring of the Air in the sealed Leg was so great, as to equiponderate a Column of Mercury of 29 Inches in Length. Boyle against Linus.



3. A Vial filled to but a fourth Part with Quick-silver, had a long and slender Glass Pipe fastened into its Neck with Sealing-Wax, or Cement, whose lower Orifice was a good way under the Quicksilver in the Vial; then having blown in a little Air, to try whether the Vial was well stopp'd, it was convey'd into a long and slender Receiver; and after the Air was drawn off by the Pump, the Spring of the included Air within the Bottle, impelled the Mercury up to the Height of 27 Inches in the Pipe, and there kept it suspended, 'till upon the Re-admission of the Air, the Quicksilver fell down to its first Station in the Pipe. This Experiment Mr. Boyle often tried, and with desired Success.

And when it was tried with a Bottle that held a Quart, the Spring of such a Quantity of Air was able to raise the Mercury up to 29 Inches one Eighth. But nothing could make it rise above the common Height of the Quicksilver in the Baroscope.

4. Into a Copper Vessel of a Cylindrical Shape, was put almost Water enough to fill it, and then was immersed into it, and kept under Water by a Weight, a square Glass Vial that would hold nine or ten Ounces of Water, and was well stopp'd: After this, Mr. Boyle placed the Copper Vessel in his *Pneumatical Engine*, and pumping up the Air, he found that the Spring of the Air included in the Vial broke it all to Pieces, though under Water, with a great Noise, and made a kind of Smoak, or Mist, appear above the Surface of the Water.

Which Experiment proves both the great Force of the Natural Spring of the Air, when the Weight of the Atmosphere is removed; and also that the Weight of the Atmosphere acts upon Bodies under Water; for that could, by its universal Pressure, keep the Spring of the Air in the Bottle bent while it was under the Surface of the Water; but when once *that*, by plying the Pump, was taken off, the Elastick Particles unbent themselves violently, and broke the Vial. See the Experiments about the Pressure of the Air's Spring on Bodies under Water.

The Spring of the Air, is equal every where in a natural State to the Weight of the incumbent Atmosphere; just as if a Person should squeeze, or compress together, either by the Force of his Hand, or by a Weight, any Parcel of Wool, or such Elastick Bodies, the Wool would, by its Spring, equally press against the Hand, or Weight. According to the third Axiom of Sir Isaac Newton's Principia, *Actioni contrariam semper & æqualem esse Reactionem*.

The accurate Dr. Hook, on Experiments well made, thinks we may conclude the Spring of the Air to be Reciprocal to its Extension. *Micrograph.* p. 227.

And the Resistance of the Spring of the Air, is found to be nearly equal to the Weight, or Force, that compresses it; and the Spaces that the same Air occupies under differing Pressures, are reciprocally as those Pressures.

The Quantity of the Dilatation and Expansion of Air only by the Operation of its Spring, without any additional Heat, Mr. Boyle found to be so great, that a Bubble of Air, included in a proper Glass Pipe almost filled with Water, was extended to above 150 times its former Dimensions; and he believes would have taken up 200 times its for-

mer Room, had the Tube been long enough to have tried the Experiment. *New Exper. Phys. Mech. Edit. 3. p. 32, 33.*

He found also, that a Cylinder of Air of an Inch in Diameter, and less than two Inches in Length, would, when included in a Bladder, and the Weight of the Atmosphere taken off by pumping, by its bare Spring only raise a Weight of above ten Pounds *Averdupois*.

He found also, that the Spring of a Cylinder of Air of two Inches Diameter, and of the former Length, was in the same Engine able to raise up forty-two Pound Weight.

Whence it appears, that the Force of the Spring of different Cylinders of Air, is in a duplicate Ratio to the Diameters of those Cylinders.

The Spring of the Air, may be explicated either by supposing the Air near the Earth to consist of an Heap of such little Springy or Elastick Bodies lying one upon another, resembling those of a Fleece of Wool.

Or else, according to D. Cartes his way, by supposing, that the Air is nothing but a Congeries of flexible Particles of several kinds of Figures and Sizes, which are raised by Heat into the fluid and subtle *Ethereal Matter* that surrounds the Earth, and by the continual Agitation of that Matter, wherein those Particles swim, are so whirled about, that each Corpuscle endeavours to beat off all others from coming within the little Sphere requisite to its Motion about its own Centre, and (in case any, by intruding into that Sphere, shall oppose its free Rotation) to drive it away.

SPRING a *Mast*, so the Seamen call it, when a Mast is only crack'd, but not quite broken, in any Part of her; as in the *Partners*, the *Hounds*, &c. then they say, *The Mast is sprung*.

SPRING, in *Physick*, is a natural Faculty or Endeavour, that Bodies have of returning to their first State, after they have been by Violence put out of the same, by compressing, bending them, or the like. This is called the *Elastick Force*.

SPRING-*Arbor*, in a Watch, is that Part in the middle of the Spring-Box which the Spring is wound or turned about, and to which it is hooked at one End.

SPRING-*Box*, is that Cylindrical Box or Frame that contains within it the Spring of a Watch, or other Movement.

SPRING-*Tide*, is the encreasing higher of a Tide after a dead Niep; this is about three Days before the Full or Change of the Moon; but the Top, or highest of the Spring-Tide, is three Days after the Full, or Change; then the Water runs highest with the Flood, and lowest with the Ebb, and the Tides run more strong and swift than in the Nieps.

SPRINGS, and *Fountains*. Concerning the Origin of these, there is much Dispute, especially of such as are found on the Tops of the high Mountains.

Some, as Dr. Hook, Dr. Plott, and many others, think that they arise from the Sea-water percolated through the Bowels of the Earth, which by that means being deprived of its Salt, is rendered much lighter than before, and so is capable of rising up to the Height we commonly find Springs at, as Water rises in a Filtre, or in very small Tubes, &c.

And Dr. Hook hath a pretty Experiment about this, in his *Microgr.* p. 25.



But I cannot see how by this Hypothesis, supposing the Gravity of the whole Atmosphere could be taken off, Water can arise above 34 or 35 Foot above the Level of the Ocean.

The learned Dr. *Halley* supposes them to be caused from the Vapours exhaled by the Sun out of the Sea, &c. Of which see an Account under the Word *Vapour*.

The Ingenious Dr. *Woodward*, in his Natural History of the Earth, supposes, that the great Abyss of Waters placed in the Bowels of the Earth, is the standing Fund and Promptuary which supplies Water to the Surface of the Earth, and furnishes as well Springs and Rivers, as Vapours and Rain.

For he asserts, that there is a nearly uniform, and constant Fire or Heat, disseminated throughout the Body of the Earth, and especially in the inferior Parts of it: The Bottoms of the deeper Mines being very sultry, and the Stone and Ores there being very sensibly hot even in Winter. That 'tis this subterraneous Heat which evaporates and elevates the Waters of the Abyss, buoying it up indifferently on all Sides, and towards all Parts of the Surface of the Globe.

That this rising Vapour, or Water, pervades not only the Fissures and Intervals of the *Strata*, but the very Bodies of the *Strata* themselves, permeating the Interstices of the Sand, Earth, or other Matter, whereof they consist; yea, even the most firm and dense Marble and Sand-stone; for these give Admission to it, tho' in lesser Quantity, and are always found saturated with it; which is the reason that they are softer, and can be cut much more easily when they are first taken out of the Earth, than they can afterwards, when they have lain some time exposed to the Air, and when that Humidity is evaporated.

This Vapour he asserts to proceed directly up towards the Surface of the Globe on all Sides, unless when impeded and diverted by the Interposition of *Strata* of Marble, the denser Sorts of Stone, or other like Matter, which is so close and compact, that it can admit it only in a smaller Quantity, and this very slowly too.

And when it is thus intercepted in its Passage, the Vapour, which cannot penetrate the *Stratum* directly, will some of it glide along the lower Surface of the *Stratum*, permeating the Horizontal Interval which is betwixt that and the next *Stratum* lying underneath it; the rest will pass the Interstices of the Mass of the subjacent *Strata*, whether they be of laxer Stone, of Sand, Marble, or the like, with a Direction parallel to the Site of those *Strata*, 'till it arrives at their perpendicular Intervals.

And when the Water is once come to these Intervals, in case the *Strata*, whereby the ascending Vapour was collected, and condensed into Water, (as we usually speak) in like manner as by an Alembick, happen to be raised above the Level of the Earth's Surface; as those *Strata* always are, whereof Mountains do consist; then the Water being likewise got above the said Level, flows forth of those Intervals or Apertures; and if there be no Obstacle without, forms *Brooks* and *Rivers*. But where the *Strata*, which so condense it, are not higher than the mean Surface of the Earth, it stagnates at the Apertures, and only forms *standing Springs*.

He adds, that tho' this Supply of Water from the Abyss, be continual, and nearly the same at all Seasons, and alike to all Parts of the Globe, yet when it arrives at or near the *Surface of the Earth*, where the Heat (the Agent which evaporates and bears it up) is *not so constant* and uniform, as is that Resident within the Globe, but is subject to Vicissitudes and Alterations, being at certain Seasons greater than at others; being also greater in some Climates and Parts of the Earth than in others: It thence happens, that the Quantity of *Water at the Surface of the Earth*, tho' sent up from the Abyss with an almost constant Equality, is *various and uncertain*, as is the Heat there at *some Seasons*, and in *some Countries*, the Surface abounding, and being even drowned with the Plenty of it, the Springs full, and the Rivers high: At *other Seasons*, and in *other Countries*, both Springs and Rivers may be exceeding low, and sometimes totally fail.

When the Heat in the exterior Parts of the Earth, and in the ambient Air, is as intense as that in the interior Parts of it, then all that *Water* which passes the *Strata directly*, mounting up in separate Parcels, or, in Form of Vapour, does not stop at the Surface, because the Heat there is equal both in Quantity and Power to *that* underneath, which brought it out of the Abyss.

This Heat therefore takes it here, and *bears it up*, Part of it immediately out of the Surface of the Earth, the rest through the Tubes and Vessels of the Vegetables which grow thereon, Herbs, Shrubs, and Trees, and along with it a Sort of Vegetative Terrestrial Matter, which it detaches from out the uppermost *Stratum* wherein these are placed; this it deposes in them for their Nutriment as it passes through them, and issuing out at their Tops and Extremities, it marches still on, and is elevated up into the Atmosphere, to such an Height, that the Heat there being less, it becomes condensed, unites, and combines into small Masses or Drops, and at length falls down again in *Rain, Dew, Hail* or *Snow*.

And for the other Part of the Water, which was condensed at the Surface of the Earth, and sent forth collectively into *standing Springs and Rivers*; *this* also sustains a Diminution from the Heat above, being evaporated more or less in Proportion to the greater or lesser Intensity of the Heat, and the greater or lesser Extent of the Surface of the Water so sent forth.

And as these Evaporations are *at sometimes greater*, according to the greater Heat of the Sun; so wherever they alight again in Rain, 'tis so much superior in Quantity to the Rain of colder Seasons, as the Sun's Power is then superior to its Power in *those Seasons*: This is apparent in our Northern Clime, where the Sun's Power is never very great, but yet our Rains in *June, July* and *August* are much greater than those of the colder Months, the Drops larger, and consequently heavier, and falling much thicker and faster than at other times.

But much more apparent is this in the Regions of the Earth, nearer to, or under the Equator, where the Sun having a much greater Force, their Rains (which are Periodical, happening usually about the same time, and lasting several Months) falls in such Quantities as to be more like descending Rivers than Showers; and by these are caused the mighty



mighty Inundations of the *Nile*, and other Rivers in those Regions.

But when the Heat in the *exterior* Parts of the Earth, and in the ambient Air, is less than that in the *interior*, the *Evaporations* are likewise less, and the Springs and Rivers do not only cease to be *diminished*, proportionably to the Relaxation of the Heat, but are much *augmented*, a great Part of the Water which ascends to the Surface of the Earth, stopping there for want of Heat to amount it thence up into the Atmosphere, and saturating the superficial, or uppermost *Strata* with Water; which by Degrees drains down into *Wells*, *Springs*, and *Rivers*, and so makes an Addition to them, and is the Reason that *these abound with Water* in the *colder Seasons*, so much more than they do in the hotter.

And the Water which is thus dispensed to the Earth and Atmosphere from the great Abyss, being carried down by *Rains* and by *Rivers* into the Ocean, which communicates with the Abyss, is by that means restored back again to it; and from thence it returns again, in a continual Circulation, to the Surface of the Earth, in Vapours and Springs.

SPRINGY, or *Elastick Bodies*, are such as having had their Figure changed by the Stroke or Percussion of another Body, can recover again their former Figure; which Bodies that are not Elastical will not do. Thus, if a Piece of Steel be bent any way, it will recover again its former Straightness; but a Piece of Lead will stand bent in any Form.

SPUNGING of a Great-Gun, is clearing of her Inside, after she hath been discharged, with a Wad of Sheep-skin, or the like, rolled about one End of the Rammer: Its Design is to prevent any Parts of Fire from remaining in her, which would endanger the Life of him who should load, or charge her again.

SPUN-YARN, or Rope-yarn, whose Ends are beaten or scraped thin, in order to fasten one Piece to another, that so it may be as long as is necessary: It is of use to make *Caburns*, and for many other Purposes aboard a Ship.

SPURIAE. See *Nothæ costæ*.

SPURIOUS *Diseases*, are such as in some Symptoms cannot be brought under any distinct Head; and for that Reason are called by the Name of some Disease to which they most agree; and hence they are often denoted *Nothi*, or *Bastard Diseases*.

SPURIOUS FLESH, in *Anatomy*, is such Flesh as is of a Constitution quite different from all the rest, as the Flesh of the *Lips*, *Gums*, *Glans*, &c.

SPURKETS, are the Spaces in a Ship's Side, betwixt the upper and lower Futtocks, or betwixt the Rungs fore and aft.

SQUADRON of *Ships*, is a Division, or Part of a Fleet, commanded by a Vice or Rear-Admiral, or some other Commander, or *Commadore*, as they call it; but the Number of Ships in it is uncertain.

SQUADRON, is a Body of Horse, whose Number is not fixed; but usually is from 100 to 200 Men, according to the General's Pleasure, the Strength of the Army, and as Occasion serves. Usually a Squadron consists of three Troops, each of 50 Men, and it never exceeds 200 Men, because a greater Number than that cannot be advan-

tageously posted, nor have room to act in *narrow Ground*, *Woods*, *Marshes*, *Defiles*, &c. The eldest Troop takes the *Right* of the Squadron, and the second the *Left*, and the youngest the Centre. A Squadron is always drawn up three deep, or in three Ranks, with the Length of a Horse between each Rank. The Standard is always in the Centre of the first Rank.

SQUAMMOSA *Sutura*, is one of the Sutures of the Bones of the Skull; so called, because the Parts of the Bones united by the Suture, do lie very slope, and like Scales.

SQUARE, is an Instrument of Brass, or Wood, having one Side Perpendicular, or at Right Angles to the other; sometimes made with a Joint to fold (for the Pocket) and sometimes has a Back, to use on a Drawing-Board, to guide the Square.

SQUARE Figure, in *Geometry*, is one whose Right-lined Sides are all equal, and its Angles all right. See *Quadrilateral*: For its Area, see *Area*.

SQUARE Number, is one multiplied into itself; as 4, which arises from the Multiplication of 2 by 2; and 9, the Product of 3 by 3; also 16 made by 4, multiplied by 4, &c.

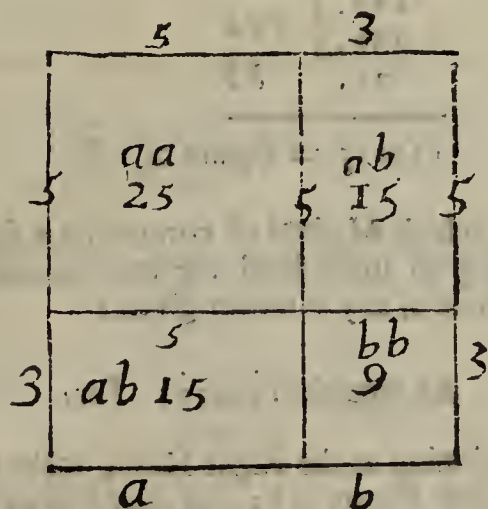
And a Square Number may be ranged into the Form of a Square, but that which cannot be so ranged, cannot be a Square Number.

The Square of any Number, or Line, as  $5 + 3$ , or  $a + b$ , divided into two Parts, is equal to the Sum of the Squares of those Parts, and also to the double Rectangle, or Product of those Parts, as is plain from only multiplying  $a + b$  by itself Algebraically. See *Euclid*, *Lib. 2. Prop. 4*.

Thus the Square of  $5 + 3$ , or 8, which is 64, is equal to

$$\begin{array}{r} a a \ 25 \\ b b \ 9 \\ 2 a b \ 15 \\ \hline \end{array}$$

$$Q a + b = a a + 2 a b + b b = 64$$



To compose any Square Number according to this Proposition.

$$\begin{array}{r} 2 \ 5 \\ \hline 4 \ . \ . \ a a \\ 2 \ 0 \ . \ 2 a b \\ . \ 2 \ 5 \ . \ b b \\ \hline 6 \ 2 \ 5 = \square \ 25 \end{array}$$



1. Write the Number down, with the Distance of one Place between each Figure.

2. Find the Square of 2, the first Figure to the Left Hand, writing it down under 2.

3. Then write the double Rectangle of 2 multiplied by 5, *i. e.* 20, under 4, as in the Margin.

4. Then square 5, and write its Square down in that Order, as you see; and adding all together into one Sum, you will have  $625 = \square 25$ .

When a Number consists of more than two Places, proceed thus.

1. Find the first Square as before.

2. Multiply the two first Figures (towards the Left Hand) and write down the Product twice, one under another.

3. Then find the Square of the second Figure, which write in its proper Order as before; add all these into one Sum for a new Square of  $a$ .

4. Then multiply the third Figure into the second, which taken together make  $a$ ; and write its Product down twice as before (in *Step. 2.*)

5. Square the third Figure, and subscribe its Square as before (in *Step 3.*) then add all into one Sum, and repeat this Process as often as there is Occasion; the last Sum of all is the true Square required.

Thus,

$$\begin{array}{r}
 3 \ 6 \ 5 \\
 \hline
 9 \dots \quad a \ a \\
 18 \dots \} \quad 2 \ a \ b \\
 18 \dots \} \\
 36 \dots \quad b \ b \\
 \hline
 1296 \dots a \ a \\
 180 \dots \} \quad 2 \ a \ b \\
 180 \dots \} \\
 25 \dots \quad b \ b \\
 \hline
 \end{array}$$

$$133225 = \text{Square of } 365.$$

From which Method of composing a Square, it will be easy to understand the way to extract the Square Root of any Number given:

As suppose  $133225$ . For,

1. Beginning at the Right Hand, make a Point over the first Figure (5); and after that over every other Place alternately: Which Points shew you the Number of Places in the Root.

2. Find the nearest Square Root to the first Part 13, which is 3; write it in the Quotient, and then place its Square (9) under, and subtract it from 13. This Root is  $a$ , and the Square  $a \ a$ .

3. To the Remainder (4) bring down the next Square 32, which will make 432, and it will be

equal to  $2 \ a \ b + b \ b$ , in the last Step of all, else always bigger, and is called the *Resolvend*. Then double the Figure (3) in the Quotient, and make it a Divisor to all the *Resolvend*, except the last Figure towards the right Hand, enquiring how often you can have 6 in 42, and place the Answer 6 (for though you can have it seven times, yet 7 must not be taken, because 'tis too large) in the Quotient, and also after 6 in the Divisor. Then multiply the thus augmented Divisor by 6, and write the Product under, and subtract it from the *Resolvend*: To the Remainder 36 bring down the next Square 25, and then you have 3625 for a new *Resolvend*: Then, as before, double the Quotient 36, which makes 72 =  $2 \ a$ , for a new Divisor, and enquire how often you can have 72 in 362; write the Answer 5 =  $a$  in the Quotient, and also after the Divisor; and multiplying the augmented Divisor by it, you will have a Product  $3625 = 2 \ a \ b + b \ b$ ; which subtracted from the *Resolvend*, leaves nothing, and so the Work is over, and the true Root found to be 365. If there had been more Points, the Work in this third Step must have been repeated 'till all was done.

The Example follows:

$$\begin{array}{r}
 133225 \quad (365 \\
 a \ a = 9 \\
 \hline
 2 \ a + b = 66) \quad 432 = \text{Resolvend.} \\
 \quad \quad \quad 396 = 2 \ a \ b + b \ b \\
 \hline
 2 \ a + b = 725) \quad 3625 = \text{Resolvend.} \\
 \quad \quad \quad 3625 = 2 \ a \ b + b \ b \\
 \hline
 0000
 \end{array}$$

But when a whole Number hath not a Square Root exactly expressible by any rational Number, then to approach infinitely near the exact Root, proceed thus.

Place as many Pairs of Cyphers on the right Hand of the Remainder, as you would have Decimal Places in the Root, and work as before, distinguishing them from the Integers by a Comma, thus: If the Square Root of 12 be desired to three Places in Decimals; annex six Cyphers to 12, and 'twill stand thus:

$$12, 000000$$

Whose Square Root being extracted, is found to be 3, 464, or  $\frac{464}{1000}$ ; but because of the Remainder, it must be that 3, 464 is less than the true Root, and 3, 465 greater than it; yet not wanting the  $\frac{1}{1000}$  of an Unit of the true Root.

The Square Root of a Vulgar Fraction is thus found.

First, if the Fraction be not in its least Terms, let it be reduced to the least Terms; then extract the Square Root of the Denominator for a new Denominator, and of the Numerator for a new Numerator; this new Fraction shall be the Square Root of the Fraction proposed. Thus the Square Root of  $\frac{1}{16}$  is  $\frac{1}{4}$ , of  $\frac{1}{4}$  is  $\frac{1}{2}$ .



If the Vulgar Fraction given, be incommensurable to its Square Root, both in the given Terms, and also in any other Terms that it is reducible to; then reduce the said Vulgar Fraction into Decimals, consisting of an even Number of Places; and then extract the Square Root thereof by Approximation, according to the Precepts already delivered.

Thus: If the Square Root of  $\frac{3}{4}$  be required, its equivalent Decimal is .75, whose Square Root is 86602, &c. Therefore the Square Root of  $\frac{3}{4}$  is 86602 *ferè*.

If a mix'd Number were given for Extraction, whose Fractional Part is express'd in Terms of a Vulgar Fraction, reduce it into an improper Fraction, and (if commensurable) extract the Square Root of the Numerator and Denominator (as before); observing to reduce the Fractional Part of the mix'd Number (or the improper Fraction equivalent to the mix'd Number) into its least Terms.

Thus: the Square Root of  $5\frac{4}{9}$  is  $2\frac{1}{3}$ ; for the improper Fraction equivalent to  $5\frac{4}{9}$  is  $\frac{49}{9}$ , and the Square Root of  $\frac{49}{9}$  is  $\frac{7}{3}$ , or  $2\frac{1}{3}$ .

To extract the Square Root, according to the Method of converging Series.

Suppose  $a a = c = 2$ .

For  $a$  take any Binomial, as suppose  $r + S$ ; 'tis best to make  $r = 1$ , (*i. e.*) to the first Root, or Side of the given Square, because then  $S$  will converge the sooner.

Then will  $r r + 2 r S + S S = a a = c$ .  
Reject the Power of  $S$ , as being of small Value:  
Then will  $r r + 2 r S = c$ , or  $2 r S = c - r r$ .

Divide all by  $2 r$ ; and then  $S = \frac{c - r r}{2 r}$ , which is the standing *Theorem*.

Suppose therefore  $r = 1$ , then  $\frac{c - r r}{2 r} = \frac{2 - 1}{2} = \frac{1}{2}$ .

Make  $2 r$  the Divisor) 1, 0 (, 5 =  $S$ .  
To the first  $r = 1$ , add, 5 =  $S$ , for a second  $r$ , in order for a new Operation.

Then 1, 5 is the new  $r$ , the Square of which is 2, 25 =  $r r$ ; from which subtract  $2 = c$ , because 2 is less than 2, 25, and 'twill stand thus.

$$\begin{array}{r} r r = 2, 25 \\ - c = 2 \\ \hline 2 r = 3) 0, 25 \end{array}$$

Which must be divided by  $2 r = 3$ , and the Quotient will be  $0, 83 = S$ ; which having a defective Sign, must be subtracted from the last.

$$\begin{array}{r} t = 1, 5 \\ - 0, 83 \\ \hline 1, 417 \end{array}$$

Which will be a new  $r$  for a third Operation; and its Square being 2, 007889 =  $r r$  (as before greater than  $2 = c$ ). Take  $2 = c$  from it, thus;

$$\begin{array}{r} r r = 2, 007889 \\ - c = 2 \\ \hline \end{array}$$

Leaves  $0, 007889 = S$ .

Which being divided by twice the last  $r = 2, 834$ , gives in the Quotient  $0, 002783 = S$ ; and this  $S$  subtracted from the last.

$$\begin{array}{r} r = 1, 417 \\ 0, 002783 \\ \hline 1, 414217 = a \end{array}$$

Which gives the Root to seven Places at three Operations.

But if more Exactness be necessary, call it a new  $r$ , for a fourth Operation, and proceed just as before.

*N. B.* This Method, which is Mr. *Raphson's*, is very pretty, but it labours under two Inconveniencies, *viz.* The greatness of the Divisors, and the high Involutions; especially in extracting Roots out of higher Powers, as the Cube, Biquadrate, Fifth, Power, &c.

To obviate which, 'tis much better to use the following way, which is Mr. *Ward's*.

Let, as before,  $a a = c = 2$ , and  $r + S = a$ .

Then  $r r + 2 r S + S S = a a = c$ .

Divide all by 2; then 'tis  $\frac{1}{2} r r + r S + \frac{1}{2} S S = \frac{c}{2}$  the Resolvend; and  $r S + \frac{1}{2} S S = \frac{1}{2} c - \frac{1}{2} r r = D$ , the Dividend.

Whence arises this *Theorem*,  $\frac{D}{r + \frac{1}{2} S} = S$ , by dividing all by  $r + \frac{1}{2} S$ .

Let then, as before, the Square Root of  $2 = C = a a$ , be required.

First, take  $r = 1$ ; then halve the Resolvend  $\frac{C}{2} = 1$ : And from it take  $\frac{1}{2} r r = 5$ , there remains  $5 = D$ . Make

$r = 1$  the Divif.) . 50 (4 =  $S$ . subf.  $\frac{1}{2} S S = 8$  under  
48 =  $r S + \frac{1}{2} S S$  [the Cypher.

Di. =  $r + S = 1, 4$ ) 20 (1, =  $S$   
145 =  $r S + \frac{1}{2} S S$

Di. =  $r + S = 1, 41$ ) 5500 (3 =  $S$   
4234, 5 =  $r S + \frac{1}{2} S S$

$r + S = 1, 413$ ) 126550 (8 =  $S$   
113072 =  $r S + \frac{1}{2} S S$

$r = S = 1, 4138$ ) 1347800 (9 =  $S$   
127246, 5 =  $r S + \frac{1}{2} S S$

1, 41389) 7533500 (5 =  $S$   
7069462, 5 =  $r S + \frac{1}{2} S S$

$\therefore a = 1, 413895. 464037, 5.$



This Root  $a = 1,413895$  differs from the former Root found, but by  $0,000022$  (a little more than  $\frac{1}{100000}$ ) for no exact Root can be found by either way.

Here also, if more Exactness had been required, the Remainder encreased by Cyphers might have been made a new Dividend, and  $1,413895$  a new Divisor; and so you may proceed on as far as you think fit.

The vast Advantage of this Method above the former, any one will soon find that will try both.

*An Example of this way, in a true Square Number.*

The Square Root of  $133225$ , is required.

$$\begin{array}{r}
 r = 3 \quad 66612.2 = \frac{1}{2} C. \\
 - 4, 5 = \frac{1}{2} r r SS \\
 \hline
 \text{Divisor} = r = 3 \quad 216 \quad (6 = S. \\
 \quad 198 = r S + \frac{1}{2} \\
 \hline
 r = 36 \quad 1812, 5 \quad (5 = S \\
 \quad 1812, 5 = r S + \frac{1}{2} S S \\
 \hline
 0000, 0
 \end{array}$$

Therefore  $a = 365$ .

**SQUARE Battle**, or *Battalion* of Men, is one that hath an equal Number of Men in Rank and File.

To form any Number of Men into a Square Battle, as suppose  $500$ , extract the nearest Square Root of  $500$ , which is in Integers  $22$ ; and that will give the Number of Men for Rank and File. There will be a Remainder of  $16$  Men, who may be disposed of as the Commander thinks best.

**SQUARE Battalion of Ground**, is when the Ground of the Flanks is of the same Extent as the Ground of the Front and Rear. To make a square Battalion of Ground; as suppose the Number were  $60$ ; multiply  $60$  by  $3$ , the Number of Feet which every Man takes up in Front, the Product will be  $180$ : Divide that by  $7$ , which is the Number of Feet each Man takes up in Depth, or which is the Distance of the Ranks, the Quotient, without a Fraction, will be  $25$ , whose square Root is  $5$ ; which will give the Number of Men in File. And if you divide the first given Number  $60$  by this Root  $5$ , you will quote  $12$ , which is the Number of Men in each Rank.

**SQUARE Hollow**, or *hollow Square*, in the Art Military, is a Body of Foot drawn up, with an empty Space in the Middle for the Colours, Drums and Baggage, facing and covered by the Pikes every way to keep off the Horse.

**SQUARING**. By the Word *Squaring*, Mathematicians understand the making of a Square equal to any Figure given. Thus the *Quadrature*, or *Squaring* of the Circle, is the finding a Square equal to the Area of a Circle, which hath not yet been done Geometrically.

**SQUINANCY**, or *Quinsey*, a Swelling and Inflammation in the Throat. See *Angina*.

**STABLE-STAND**, is the Term for one of the four Evidences, or Presumptions, whereby a Man is convicted, to intend the stealing the King's Deer in the Forests. The other three are *Dog-draw*, *Back-bear*, and *Bloody-hand*. This *Stable-stand* is when a Man is in *Stabili Statione*, at his *Standing* in the

Forest with a *Cross-bow*, or *Long-bow*, ready to shoot at a *Deer*; or else when he is *standing* close up by a Tree, &c. with Greyhounds in a *Leash* ready to slip.

**STAGMA**, are Juices of Plants mix'd together in order to Distillation.

**STAKE**, is the Name of a small *Anvil* used by Smiths; sometimes it stands on a broad Iron Foot, on the Work-Bench, to be moved up and down occasionally; and sometimes it hath a strong Iron Spike at the Bottom, by which 'tis fixed to some Place on the Work-Bench. Its Use is to set small and cold Work streight, by hammering it on the Stake, or to cut or punch upon with the *cold Chissel*, or *cold Punch*.

**STALACTITÆ** [of *σταλαγμις*, Gr. a Drop, or Dropping] are a Sort of stony, sparry Icicles which hang down from the Top, or Arches of Grotto's, Caves, or Subterranean Caverns, and from the Roofs of the Buildings and Capitals of the Pillars of such Places as are built over the *Thermæ*, or Hot-Springs. Of this kind are the *Sal Alumen*, and *Vitriolum Stalacticum*, the *Minera Ferri-stalactica*, the *Vitriolum Capillare*, and the *Alumen Capillare*, &c. These *Stalactica*, Dr. Woodward faith, should rather be called *Stagonitæ*.

**STALLAGE**, was a customary Rent paid in Fairs and Markets, for the Liberty of a Stall or Standing, by the *Stallangers*, or the *Creamers*, i. e. those Traders who exposed their Goods to Sale on the said Stalls. In Scotland they call it *Stallenge*; the Romans called it *Siliquaticum*, from *Siliqua*, which was their first and least Weight, a kind of *Caract* of four Grains.

**STAMINA**, in the *Animal Oeconomy*, are those simple or equal Parts which existed first in the *Embryo*, or even in the *Semen*; and by the Distinction and Accretion of which, by additional Juices, the humane Body, at its utmost Bulk, is supposed to be form'd.

**STAMINA**, in *Botany*, are those little fine Threads or Capillaments which grow up within the Flowers of Plants encompassing round the *Style*, and on which the *Apices* grow, at their Extremities. Whence the *Botanists* call that a

**STAMINEOUS Flower**, which is so far imperfect, as to want those coloured Leaves which are called *Petals*, and consists only of the *Stylus* and the *Stamina*.

And such Plants as do bear these *Stamineous Flowers*, Mr. Ray makes to constitute a large Genus of Plants, which he calls *Herbæ flore Imperfecto five apetalæ Stamineæ*.

And these he divides into such as,

1. Have their Fruit or Seed totally divided from the Flower; and these are such Plants as are said to be of *different Sexes*: The reason of which is, that from the same Seed some Plant shall arise with Flowers and no Fruit, and others with Fruit and no Flowers; as *Hops*, *Hemp*, *stinging Nettles*, *Spinach*, *Cynocrambe*, *Mercurialis*, and *Phyllon*.

2. Such as have their Fruit only a little disjoin'd from their Flowers; as the *Ambrosia*, *Bardana minor*, *Ricinus*, and the *Heliotropium Tricoccon*.

3. Such as have their Fruit immediately contiguous, or adhering to their Flower: And the Seed of these is either,



1. *Triangular*: And of this Sort some are lucid and shining, as the *Lapathum*, *Rhabarbarum*, and *Bistorta*, to which also may be reckoned the *Perficaria*.

Others are rough, and not shining; as the *Hel-leborus Albus*, *Fegopyrum*, *Convolvulus niger*, and the *Polygonum*.

2. Such as have a roundish Seed, a little flattened or compressed, or of any other Figure but the former *Triquetrous*, or *Triangular* one. And these have their Flower, or the Calyx of the Flower adhering to the *Bottom* or *Basis* of the Seed or Fruit; as the *Potamogiton*, *Blitum Silvestre*, *Parietaria*, *Atriplex*, *Blitum Sativum*, *Amuranthes Hoclocerius*, and the *Saxifraga Aurea*.

3. Such whose Flowers adhere to the Top or uppermost of the Seed; as the *Beta*, *Asarum*, *Archimilla*.

And to these kind of Plants Mr. Ray reduces also the *Raligeniculatum Sedum fruticosum*, the *Scoparia*, or *Belvidere* of the Italians.

**STAMPING-MILL**, called also a *Knocking-Mill*, is a Mill used in the Tin-works to bruise the Ore small. See the Description of it under *Tin*.

**STANCHIONS** in a Ship, are those Timbers which being set up Pillar-wise, do support and strengthen the waste Trees.

**STANDARD** for *Gold-Coin* in *England*, is twenty-two Caracts of fine Gold, and two Caracts of Copper; and the *French* and *Spanish* Gold are nearly of the same Standard. See *Caract*.

For *Silver-Coin*, eleven Ounces and Two-penny Weight of fine Silver, and Eighteen-penny Weight of Copper, being melted together, is the true Standard, and such Silver is called *Sterling*. When either Gold or Silver is finer than Standard, they call it *better*; if coarser, *worse*; and they reckon the Excess, or Defect, by Caracts, and Grains of a Caract in Gold, and by Penny-weights in Silver. And it is thus discovered: They take a small Quantity and assay it; that is, weigh it very exactly, and then melt it in a Crucible with a strong Fire, so long 'till the Copper, or other *Allay* mixed with it, be burnt away. When cold, they weigh it again accurately; and if it hath lost nothing of the first Weight, they call it *fine Gold*; if it hath lost  $\frac{1}{4}$  Part of its Weight, they call it Gold of twenty-four Caracts, or one Caract better than Standard; if it have lost  $\frac{1}{2}$  Parts, then 'tis twenty-two Caracts fine, or Standard; if it hath lost  $\frac{3}{4}$  Parts, 'tis called twenty-one Caracts fine, or one Caract *worse* than Standard, &c. And so they assay Silver, only they compute its Loss by Penny-weights, &c.

**STANDING Part** of the *Sheat*, is that Part which is made fast to a Ring at the Ship's Quarter. When they say, *Over-hale the Sheat*, they mean, *Hale upon the standing Part*; but when they say, *Hale the Sheat barely*, they intend it only of the Running Part.

**STANDING Ropes**, are those Ropes which do not run in any Blocks, but are set taught, or let slack, as occasion serves; as the *Sheat-stays*, *Back-stays*, and the like.

**STANDING Part of a Tackle**, aboard a Ship, is the End of the Rope where the Block is seized, or fasten'd; as the other which is haled, is called *Fall*.

**STANNARIES**, are the Mines and Works where (*Stannum*) Tin is dug and smelted; as in *Cornwall*, and other Places. There are several Laws about, and Liberties granted to the *Stannary-Courts* in several Acts of Parliament; as in the Time of *Edw. 1.* and afterwards, as abridg'd by *Edw. 3.* and in *17 Car. 1. c. 15.*

**STAPES**, or the *Stirrop*, because of its Resemblance to a *Stirrop*, is a little Bone in the Ear, of a Triangular Figure, and is made of two Branches set upon a flat Basis, which stands upon the *Foramen Ovale*; the Union of the two Branches is called the Head of the *Stapes*, in which there is a small Cavity, wherein lies another little Bone.

**STAPHYLOMA** [*σταφυλωμα*, Gr.] is a Disease of the Eye, in which the two Tunicks of the Eye, *Cornea* and *Uvea*, being broken, fall outward in the Shape of a Grape.

**STAPLE**, signifies this or that Town, City or Place where the Merchants of *England* were, by Act of Parliament, to carry their Wool, Cloth, Lead and Tin, &c. and such like *Staple*, or *Standing* Commodities of this Land, in order to their being sold by the Great. These Places you will find in several Statutes, appointed and altered by the Kings of *England*, from the second Year of *Edw. 3.* to the fifth of *Edw. 6.* and what Officers these *Staples* had belonging to them, you may see in *Anno 27 Edw. 3. Stat. 3. c. 21.* The *Staple* Commodities of this Land are Wool, Leather, Woolfells, Lead, Tin, Butter, Cheese and Cloth; as appears by *14 Rich. 2. c. 1.* tho' some will allow only the first five.

**STAR**, in *Fortification*, is a Work with several Faces, generally composed of from five to eight Points, with Salient and Re-entring Angles flanking one another; every one of its Sides containing from twelve to twenty-five Fathoms.

**STAR**, in *Pyrotechny*, of a Composition of Gunpowder, and other combustible Matters, which being sent Aloft into the Air, exhibits the Appearance of real Stars.

**STAR**. All Deeds, Obligations, Contracts, Releases, &c. of the *Jews*, were anciently called *Stars*, from the *Hebrew* *Shetar*, a Deed or Contract. These were sometimes written in *Hebrew* and *Latin*, but usually in *Hebrew* alone.

**STARBOARD**, the Right-Hand Side of a Ship, as *Larboard* is the Left: Thus they say, *Starboard the Helm*, or Helm a *Starboard*; when he that *Comds* would have the Man at the *Helm* put the *Helm* to the Right Side of the Ship.

**STAR-CHAMBER**, was a Chamber at *Westminster*, formerly so called from its Roof being painted with Stars. *Henry* the Seventh and Eighth ordered by several Statutes, that the Chancellor, assisted by others there named (*vid. 3 Hen. 7. c. 1. and 21 Hen. 8. c. 2.*) should have Power to punish *Routs*, *Riots*, *Forgeries*, *Embraceries*, *Perjuries*, and such other Misdemeanors, as were not sufficiently provided for by the Common-Law; and for which the Inferior Judges are not so proper to give Correction. But this Court, by *17 Car. 1. c. 10.* was entirely dissolved and determined, and so continues to this Day.

**STAR-Fort**. See *Fort*.

STARS.



STARS. See *Fix'd Stars*.

STATICAL *Baroscope*, an Instrument invented by the Honourable Mr. *Robert Boyle*, whose Description see in *Baroscope*.

STATICAL *Hygroscope*. See *Hygroscope*.

STATICKS, is a Science purely Speculative, being a Species of *Mechanicks*, conversant about Weights, and shewing the Properties of the *Heaviness* and *Lightness*, or *Æquilibria* of Bodies. When it is restrained to the Specifick Weights and *Æquilibria* of Liquors, it is called *Hydrostaticks*; which see.

STATION, in *Astronomy*, signifies certain Places of the *Zodiack*, where a Planet being arrived, seems to stand still for some time in the same Degree, either in ascending to its *Apogee*, or descending to its *Perigee*.

STATION, is a Place where a Man fixes himself and his Instrument, to take (as in Surveying) any Angles or Distances.

STATION-Line. See *Line of Station*.

STATION-Staff, is an Instrument consisting of two Rulers that slide to ten Foot, divided into Feet and Inches, with a moving Vane, or Sight, two of which are used with a Level; and on the Edges, there are the Links of the *Gunter's Chain* divided. It is used in Surveying for the more easy taking Off-sets.

STATIONARY; a Planet is said to be *Stationary*, when to an Eye placed on the Earth it appears for some time to stand still, and to have no progressive Motion forward in its Orbit round the Sun.

STATUS *Morbi*. See *Acme*.

STATUTE, is a Word that hath diverse Significations; as first, it signifies an Act of Parliament made by the King and the Three Estates of the Realm; in which Sense it is either General or Special. In another Signification, *Statute* is a short Writing, called a *Statute-Merchant*, or a *Statute-Staple*; which see. *Statutes* are also vulgarly taken for the *Petit-Sessions*, by 5 *Eliz cap. 4*.

STATUTE-Merchant, is a Bond acknowledged before one of the Clerks of the *Statutes-Merchant* and Mayor, or Chief-Warden of the City of *London*, or two Merchants of the said City for that Purpose assigned, or before the Mayor, Chief-Warden, or Master of other Cities or good Towns, or other sufficient Men for that Purpose appointed, sealed with the Seal of the Debtor, and of the King, which is of two Pieces; the greater is kept by the Mayor, Chief-Warden, &c. and the lesser by the said Clerks.

STATUTE-Staple, is so called either properly or improperly. A *Statute-Staple*, properly so called, is a Bond of Record, acknowledged before the Mayor of the *Staple*, in the Presence of one of the two Constables of the same *Staple*; for which Seal, the Fee is of every Pound, if the Sum exceed not 100 *l.* an Half-penny; and if it exceed 100 *l.* a Farthing; and by Virtue of such *Statute-Staple*, the Creditor may forthwith have Execution of the Body, Lands, and Goods of the Debtor. *Statute-Staple* improper, is a Bond of Record, founded upon the *Stat. 23 Hen. 8. cap. 6*. Of the Nature of a proper *Statute-Staple*, as to the Force and Execution of it; and acknowledged before one of the Chief-Justices; and in their Absence, before the Mayor of the *Staple*, and the Recorder of *London*.

STATUTO *Mercatorio*, is a Writ for the Imprisoning of him that has forfeited a Bond, called *Statute-Merchant*, until the Debt be satisfied. Of these, there is one against Lay-Persons, and another against Ecclesiastical.

STATUTO *Stapulæ*, is a Writ that lies to take his Body to Prison, to seize upon his Lands and Goods, that hath forfeited a Bond called *Statute-Staple*.

STATUTUM *de Laborariis*, is a Writ Judicial, for the apprehending of such *Labourers* as refuse to work according to the Statute, *Reg. Judic. Fol. 27*.

STAYS in a Ship, are Ropes whose Use is to keep the Mast from falling aft. All Masts, Top-Masts, and Flag-Staves, have Stays, except the Sprit-sail Top-Mast; the Stay of the Main-mast, which is called the *Main-stay*, is by a Lannier fasten'd to a Collar, which comes about a Knee belonging to the Head; the *Main-top-mast-Stay* is fasten'd to the Head of the Fore-mast by a Strap, and a Dead-man's Eye, and so is the *Main-top-gallant-mast* stayed to the Head of the Fore-top-mast; the Fore-mast and Masts belonging to it, are in the same manner stayed to the Bolt-sprit and Sprit-sail Top-sail Mast; which Stays do likewise stay the Bolt-sprit itself. The *Misfen-stay* comes to the Main-mast by the Half-deck, and the Top-mast Stays come to the Shrouds with Crows-feet. The Length of the Stay is the same with that of the Mast it belongs to.

The Main-mast, Fore-mast, with the Masts belonging to them, have also *Back-stays*, which help to keep the Mast from pitching forward, or overboard, because they go on either Side of the Ship, *To bring a Ship upon the*

STAYS, or to *stay her*, is in order to her Tacking, which is thus done: At the same time bear up the *Helm*, let fly the *Fore-sail Sheat*, let go the *Fore-bowling*, Brace the *Weather-brace* of the *Fore-sail*; the same is also done to the *Top sail*, and *Top-gallant-sail*, only their Sheats must be kept fast. If the Sprit-sail be out, then at the same time let go the Sprit-sail Sheat also, with the *Fore-Sheat*, and Brace the *Weather-brace*; but the *Tacks*, *Sheats*, *Bracings*, and *Bowlings*, of the *Main-sail*, *Main-top-sail*, and *Misfen*, are not altered. And when the Wind comes in at the Bow, which before was the *Lee-bow*, it drives all the Sails backward against the Shrouds and Masts, so that the Ship makes no Way forward, but drives with her Broad-side. Those are reckon'd the best Ships which will stay with the fewest Sails.

STEADY, a Word of Command at Sea, from him that Conns to the Man at Helm, to keep the Ship *steady* in her Course, and not to make Angles or Yaws (as they call them) in or out.

STEATOMA [*στάτωμα*, Gr.] is a preternatural Swelling, which consists of a Matter almost like Suet, of the same Colour throughout, soft; and though not easily yielding to the Touch, yet suddenly returns, the Fingers being removed, to its proper Shape and Bigness.

STEEL, is made, according to Mr. *Lemery*, p. 154, by stratifying of Plates of Iron in a large Furnace, with the Horns, or Nails, of Animals, under which is made a very great Fire: Thus is the Iron calcined; but when red hot, and near melting, they take the Plates out, and dip them suddenly in cold Water, and so they become *Steel*.

*Steel*



*Steel* is not so good as *Iron* for Medicinal Operation, because the volatile Parts are mostly purged away in the Calcination, and what remains is hardly dissolvable by the Juice in the Body.

**STEER.** To steer a Ship, is to guide or govern her by the Helm. He is the best *Steersman* that uses the least Motion in putting the Helm over to and again, and that keeps the Ship best from making Yaws; that is, from running in and out. There are three Ways to steer by.

1. By any Mark on the Land, so as to keep the Ship even by it.

2. By the Compass, which is to keep the Ship's Head upon such a Rhumb, or Point of the Compass, as best leads to her desired Port.

3. To steer as one is bidden, or conned, which is the Duty (in a great Ship) of him that is taking his Turn at Helm.

**STEERAGE**, a Part of a Ship where he standeth that *steereth*; that is, guides the *Helm* or *Rudder* of the Ship; and this in a Man of War is always before the Bulk-head of the great Cabin; and wherever the *Steersman* be placed, he must stand so, as that he can see the *Letch* of the Sails, whether they be in the Wind or not.

**STEEVE**; the Seamen say that the *Bow-sprit*, or the *Beak-head* of the Ship doth *Steeve*, when either stands too upright, and not straight enough forwards.

**STEGANOGRAPHY** [*στεγανογραφία*, of *στεγανός*, *Covert* or *Private*, and *γραφία*, *Gr. Writing*] is the Art of secret Writing, which is known only to the Persons corresponding with one another; and which, if the Letters should be opened, no one is supposed to be able to discover, or *Decypher*, as 'tis called. Though now-a-days hardly any thing can be written by this Art, but what may be decyphered, and the Sense and Meaning of it discovered. And in this Art of decyphering, that excellent Mathematician, *Dr. Wallis*, is admirably ready.

**STEGNOSIS**, is a Constriction, or stopping up of the Pores.

**STEGNOTICA.** See *Astringentia*.

**STELLATE Plants**, are, by the Botanists, called such Plants as have their Leaves growing on the Stalks at certain Intervals, or Distances, in the Form of a Radiant Star; and, according to *Mr. Ray*, this is the Tenth Genus of *English Plants*: Of this kind is *Cruciata*, or *Cross-wort*, *Mollugo*, *Wild-madder*, *Aperula*, or *Woodruff*, *Gallium*, or *Ladies Bed-straw*, *Aparine*, or *Cleavers*, *Rubia Tinctorum*, or *Dyers Madder*. To which he adds, as a-kin to this Genus, the *Nasturtium Indicum*, *Indian Cresse*, or *yellow Lark-spur*.

**STEM of a Ship**, is that main Piece of Timber which comes bowing, or bending from the Keel, below where it is *scarfed* (as they call it) that is, pieced in, right before the Forecastle. This Stem it is which guides the Rake of the Ship, and all the But-ends of the Planks (forwards) are fix'd into it. This in the Section of a First Rate Ship, is called the *Main stem*.

**STEM, in Botany**, is that Part of a Plant that arises out of the Root, and which sustains the Leaves, Flowers, and Fruit.

V o L. II.

**STENTOROPHONICK-Tube** (so called of *Stentor*, mentioned by *Homer*) or Instrument, is the Speaking-Trumpet, invented by *Sir Samuel Moreland*.

**STEP**, that Piece of Timber in a Ship, whereon the Masts, or Capstans do stand at Bottom, is called the Step of the Mast, or Capstan.

**STERCOROSUS Fluxus**, is that in which much liquid Excrement is often voided, proceeding from Excrementitious Meats corrupted in the Stomach, or a great Quantity of Excrements heap-up in the Intestines. *Blanchard*.

**STEREOBATA** [of *στερεά βαίνειν*, *Gr. to ascend firmly*] in Architecture, is the Greek Word for the first beginning of the Wall of any Building, and immediately standing on the Foundation: This is wrongly confounded with *Stylobata*, which is the beginning of a Column, or its *Pedestal*.

**STEREOGRAPHY**, [*στερεογραφία*, of *στερεός* *solid*, and *γραφία*, *Gr. Description*] is the Art of drawing the Forms of Solids upon a Plane.

**STEREOGRAPHICK Projection.** See *Projection of the Sphere in Plano*.

**STEREOMETRY** [*στερεομετρία*, of *στερεός* and *μετρία*, *Gr. to measure*] is the Art of measuring all Sorts of Solid Bodies, which how to do, you will find under the proper Names of each Body.

**STEREOTOMY** [*στερεοτομία*, of *στερεός* *Solid*, and *τομή*, *Gr. to Cut*] the Art or Science of cutting Solids, or making Sections of them, as in Profiles of Architecture in Walls, and other Solids, to be cut.

**STERLING Money**; this Word seems to come, as *Mr. Somner* hath derived it, from the Saxon Word *Steore*, that is, a *Rule* or *Standard*; and therefore it signifies that Coin or Money, which for Metal and Value, was to be a common Standard of all current Money. And this is the more probable, because such Money, at the coming in of the *Normans*, was called *Sterilensis*. As *Orderic. Vital* sub Anno 1082. *Porrigan quindecem Sterilensium*, *Dr. Kennet's Glossary*. *Esterling*, in *Stow*, is used for a Penny-weight, signifying a Penny of fine Silver, such as we now call *Standard*. But the Word *Sterling*, as being a Piece of Money, generally, if not always, signifies a *Penny*. And as for a good while together there was no other Coin but Pennies, and that *Denarius* signifies in many Authors, the same as *Nummus*, all good Standard Silver came to be called *Sterling Silver*, and good Money, *Sterling Money*, as it is to this Day.

**STERN** of a Ship, is all the hindermost or aftermost Part of her, generally speaking; but properly, 'tis only the outmost Part of her, *Abaft*.

**STERNFAST**, is some Fastnings of Ropes, &c. behind the Stern of a Ship, to which a Cable or Hawser may be brought, or fixed, in order to hold her Stern to a Wharf, &c.

**STERNPOST**, is a great Timber let into the Keel at the Stern of a Ship, somewhat sloping, into which are fastned the After-Planks; and on this Post, by its Pintle and Gudgeons hangs the Rudder.

**STERNOHYOIDES** [of *στερνόν*, *the Breast*, and *υοειδής*, *Gr.*] is that Pair of Muscles which is commonly by Anatomists said to arise from the uppermost Part of the Breast-Bone: But this is since proved a Mistake, for they arise from the internal Part of the *Clavicula*, next where its Origination is broad and fleshy, and ascends directly over the



*Sternothyreoidæus* and *Larynx*, of an equal Breadth and Thickness to its Insertion at the Basis of the Fore-Bone of the *Os Hyoides*. This, with its Partner, acting, pulls the *Os Hyoides*, together with the *Tongue* and *Larynx*, directly downwards.

**STERNOTHYROEIDES** [of *στερνει θυρεα* and *νοστις*, Gr.] is a Pair of Muscles which do arise broad and fleshy from the upper and internal Part of the *Sternum*, whence ascending on the Sides of the Wind-pipe, over the *Glandulæ Thyroideæ*, it is inserted to the inferior Part of the Thyroidal, or Scutiform Cartilage.

This, with its Partner, pulls the *Larynx* downwards, and lengthens the *Canalis*, or Distance between the *Rimula* and Tip of the *Tongue* (which latter seems to be the true *Plectrum Vocis*) whereby the Tone of the Voice is rendered grave.

**STERNUM** *Os*, the Breast-Bone, is joined to the Ribs in the foremost Part of the Breast, consisting of three or four Bones; and frequently in those that are come to Ripeness of Age, grows into one Bone: to this is joined, in the lower Part of it, the *Cartilago Eniformis*.

**STERNUTATION**, Sneezing, is a forcible driving out of the Head some sharp Matter which vellicates and disturbs the Nerves and Fibres: Or, as some say, 'tis an involuntary Motion of the Brain, which contracts the Muscles of the *Thorax* and *Abdomen*, to the Intent that the Matter which vellicates the Nostrils and Brain may be driven out.

**STERNUTATORIUM**, *sive Sternutamentum*, a sneezing Medicine, or Snuff.

**STEWARD** of a Ship, is he that receives all the Victuals from the Purser; and he is to see it well stowed in the Hold: In his Custody are all things of that Nature belonging to the Ship's use. He is to look after the Bread, and to distribute out the several Messes of Victuals in the Ship. He hath an Apartment for himself in the Hold, which is called the Steward's Room, where he sleeps and eats.

**STILE**, in *Dialling*, is the Gnomon, or Cock of a *Dial*, that casts the Shadow upon the Hour-Lines; and is always parallel to the Axis of the Earth, in all kinds of Dials.

**STILES**, the upright Pieces which go from the Bottom to the Top in any Wainscot, are by the Workmen called *Stiles*.

**STILLATITIOUS** Oils, in *Chymistry*, are such as are extracted out of Mixts by the Force of Fire; and hereby are distinguished from such as are made by *Expression*, or by pressing.

**STILLICIDIUM** *Urinæ*. See *Stranguria*.

**STILOBATUM**, in *Architecture*, is the Body of the Pedestal of any Column.

**STIMULATION**, a Property in angular or sharp Bodies, by which they cause Vibrations and Inflections of the Fibres of the Nerves, and a greater Derivation of the nervous Fluid into the Part affected.

**STIPULATION**, in the *Civil Law*, is a Contract made by Words, and not in Writing, by asking a Question, and receiving presently a proper Answer: And in this Contract the Obligation is only upon one Side, *i. e.* on the Side of the *Promiser*, who was called *Reus Debendi*, or *Promittendi*, as the *Stipulator*, or *Creditor*, to whom the Promise is made, was called *Reus Credendi*, or *Stipulandi*.

This was the old Sense; but now with us the Word *Stipulation* is commonly used for the Act of the Person obliged; and some say that the Word *Stipulator* is common both to Debtor and Creditor.

**STIRRUP** of a Ship, is a Piece of Timber put upon a Ship's *Keel*, when some of her *Keel* happens to be beaten off, and they can't come conveniently to put or fit in a new Piece; then they patch in a Piece of Timber, and bind it on with an Iron, which goes under the Ship's *Keel*, and comes up on each Side of the Ship, where 'tis nailed strongly with Spikes; and this they call a *Stirrup*.

**STOCKS**, so the Ship-Carpenters call a Frame of Timber, and great Posts made Ashore to build Pinnaces, Ketches, Boats, and such small Craft, and sometimes small Frigates: Hence we say, a Ship is on the *Stocks*, when she is a building.

**STOLONES**, are the *Suckers* which spring up from the Root of any Tree, or Plant; and which, if not cut off, will hinder the thriving of the Tree.

**STOMACH**, see *Ventriculus*. Monsieur *Chirac*, Professor of Medicine at *Montpellier*, hath by an easy Experiment shewn, that the Force of the Stomach alone (in Vomiting) without taking into Consideration the Muscles of the *Diaphragm* and *Abdomen* (whose Force together is more than that of 148000 Pound Weight) is equal to that of 12000 Pound Weight.

**STOMACHUS**, in *Anatomy*, is not the Stomach of an Animal, for that is called *Ventriculus*; but is properly the left, or upper Orifice of the Ventricle, or Stomach, by which Meats are received into it. To this Part descend Nerves from the eighth Pair, and intercostal Nerves, and are mixed and interwoven with one another. The *Greeks* calls it *καρδιον*, the *Heart*: Whence it is that a Pain which is sometimes felt in this Part, is corruptly called the *Heart-burn*; and the Region of the Stomach hereabout is called also *Scrobulus Cordis*, or the *Heart-Pit*. It hath its Fibres orbicular, that its Orifice may exactly shut or close upon the Meat and Drink received into the Stomach, to prevent Fumes coming from thence to affect the Head, and to hinder Concoction.

**STONES**, are such kind of Minerals as are hard and friable: To which also Bishop *Wilkins* annexes

*Earthy Concretions*, as being of a middle Nature between Stones and Metals, but are more soft, usually, and brittle than the former. And that Great Man distinguishes Stones into,

1. *Vulgar*, and of no Price.

2. *Middle-priced*.

3. *Precious*: And these are of two kinds, either more or less Transparent.

1. *Vulgar Stones*, or such as are of little or no Price, are distinguishable from their different Magnitudes, Uses, and Consistences, into

Greater



Greater Magnitude of Stone ; used either about

Buldings ; whether of

Walls ; chiefly being of a

Softer Consistence, whether Natural, or Factitious.

- 1 } Free-stone,  
1 } Brick.

Harder Consistence ; not easily yielding to the Tool of the Workman, growing either in Greater Masses.

2 Ragg.

Lesser Masses ; whether such as are for their Figure

More Knobbed and Unequal, used for the striking of Fire, either the more common, which is less heavy ; or the less common, which is more heavy, as having something in it of a Metalline Mixture.

- 3 } Flint,  
3 } Marchasite Firestone.

More Round and Even.

4 Pebble.

Roof or Pavement, being of a laminated Figure, either Natural or Factitious.

- 5 } Slate,  
5 } Tile.

Metals, either for the

Sharpening, or trying of them

- 6 } Whetstone,  
6 } Touchstone.

Polishing, or cutting of them ; being either of a more spongy and soft, or of a more hard Consistence.

- 7 } Pumice,  
7 } Emery.

Lesser Magnitudes, either more or less minute.

- 8 } Sand,  
8 } Gravel.

2. Middle-priced Stones, are either of a

Shining Politure, or capable of it ; whether of a Simple white Colour, and more soft Consistence,

1 Alabaster,

Sometimes White, sometimes Black, or Green, and sometimes variegated with Veins, growing in greater or lesser Masses.

- 2 } Marble, Porphyrie,  
2 } Agat.

Spotted with Red, upon a Greenish Colour, or with Spots of Gold-colour upon Blue.

- 3 } Jaspis, Heliotrope,  
3 } Lazul, Azure-stone.

Transparency, either

Brittle ; whether Natural or Factitious.

- 4 } Chrystalline,  
4 } Glass.

Fissil, into Flakes, either greater or lesser.

- 5 } Selinite, Muscovia-glass, Ising-glass,  
5 } Talk. (Spar.

Relation to Metals, attracting Iron, or making of Brasses,

- 6 } Load-stone,  
6 } Cadmia, Calaminaris.

Incombustible Nature.

7 Amiantus.

Strange Original ; not being properly Minerals, tho' usually reckoned amongst them ; but ei-

ther a Sub-marine Plant, or supposed to proceed from a Liquid Bitumen.

- 8 } Coralline,  
8 } Amber.

There are several other stony Consistencies mentioned in the Authors who write *de Lapidibus*. Some that are found in the Bodies of Animals, their Stomachs, Guts, Bladders, Kidneys, &c. several of which are denominated from the Animals in which they are found ; as *Alectorius*, *Chelidonium*, *Bezoar*, &c. Others have peculiar Names from their Shapes ; as *Astroides*, *Glossopetra*, &c. Others made of Animals, or Parts of Animals petrefied, which may be sufficiently express'd, without being particularly provided for in the Tables.

3. Precious Stones, Gems, Jewels, are such as for their Variety and Beauty are every where more esteem'd. Amongst which, some are less Transparent, which are distinguishable chiefly by their Colours, either

Representing Variety of Colours, with Dimness less or more.

- 1 } Opal,  
1 } Cats-Eyes.

Of particular Colours.

Whitish and shining ; tho' this be not properly a Mineral, but a Part of a testaceous Fish.

2 Pearl.

Red,

3 Sarduis, Cornelian, Blood-stone.

Pale, Fleishy Colour, like that of a Man's Nail.

4 Onyx.

Bluish.

5 Turcois.

Pale Purple.

6 Chalcedony.

As for that which is commonly stiled a Toad-stone, that is properly a Tooth of the Fish called *Lupus Marinus*, as hath been made evident to the Royal Society, by that Learned and Inquisitive Person, Dr. Merit.

4. More Transparent Gems may be distinguished into such as are either

Colourless ; either most hard and bright, or that which is very like to this in other respects, but only less hard and bright.

- 1 } Diamond, Adamant,  
1 } Sapphire white.

Coloured, to be ranged according to the Colours in the Rainbow.

Red, of a Lustre greater or less.

- 2 } Ruby, Carbuncle,  
2 } Granate.

Yellow, whether paler or deeper.

- 3 } Chrysolite,  
3 } Topaz.

Green, either most bright and pleasant, or of a darker kind of Sea-green.

- 4 } Emerald, Smaragd,  
4 } Beryl.

Bluish.

5 Sapphire.

Purple, or Violaceous ; more inclining to Blue, or to Yellow.

- 6 } Amethyst,  
6 } Hyacinth.

5. Such



5. Such *Earthy Concretions* as commonly grow in Mines, together with such other factitious Substances as have some Analogy to these, and are *dissolvable* by Fire or Water, may be distinguish'd by their being

*Not Inflammable* ;

More Simple ; being several kinds of Salts, whether of the

*Sea-water*, the most necessary Condiment for Meat ; or of the Air, used as a chief Ingredient in the making of Gun-powder.

1 } Salt,

1 } Nitre, Salt-petre.

*Earth* ; of a Styptick Quality, and Absterfitive, proper for the drying of Wounds, commonly boil'd up in a Consistence from a *Mineral Water* ; or that other kind of Earthy Salt dug up in great Lumps.

2 } Alum,

2 } Sal Gemmae.

*Metals* of all kinds ; sometimes call'd Sugars and Crystals, but agreeing in the common Nature with that which is stil'd

3 Vitriol, Chalcantus, Copperas.

*Vegetables*, made either by Fermentation, or by Burning.

4 } Tartar,

4 } Alkali.

*Animal Substances*, made by Distillation, called,

5 Urinous Salt.

More mix'd of other Salts ; more Volatile, or Fixed.

6 } Sal-Armoniac,

6 } Chrysocolle, Borax.

*Inflammable* ; of a more

Dry Consistence, and yellowish Colour.

7 Sulphur, Brimstone.

Clammy and tenacious Consistence.

Not sweet scented ; more Solid, or more Liquid.

8 } Bitumen,

8 } Naphtha.

Sweet-scented.

9 Ambergris.

6. *Earthy Concretions not Dissolvable*, may be distinguished by their various Colours ; being either

White and soft, according to Degrees, more or less.

1 } Chalk,

1 } Marle.

Yellowish Red, whether more Yellow or more Red.

2 } Oker, Yellow Oker,

2 } Red Oker, Ruddle.

Black ; of a finer or coarser Grain.

3 } Felt,

3 } Pit-coal, Sea-coal.

Gold-colour ; of a poisonous Nature, either as it is dug out of the Earth, or as it is sublim'd.

4 } Orpiment, Auripigmentum,

4 } Arsenick, Rats-bane.

Reddish ; often found in the same Mines with Orpiment.

5 Sandarach.

STOPPER, is a Piece of Rope (in a Ship) having a *Wale-knot* at one End, with a *Lannier* spliced into it, and at the other End 'tis made fast in the Place where 'tis to be used. Its use is to stop

the main Halliards, or the Cable. The Stopper for the *Halliards* is fastened at the Main-Knight, and it serves, when they are hoisting the Main-yard, to stop it, while the Men that hale may stay and rest a little. But 'tis chiefly used for the Cable, to stop it, that it don't run out too fast : They bind the *Wale-knot* about the Cable with the *Lanniers*, and that stops it, so that it cannot slip away. This Stopper is fastened to the Bottom of the Bitts by the Deck. The Word is, *Lay on the Stoppers*. And a Ship is said to *Ride by the Stoppers*, when the Cable is fastened or stayed only by them, and not *Bitted* ; but this is not safe riding in a Stress of Weather.

STRABISMUS, Squinting, is occasioned by the Relaxation, Contraction, Distortion, too great Length, or too great Shortness of the Muscles which move the *Eye*. *Blanchard*.

STRAIKS, in *Gunnery*, are Plates of Iron of the Length and Breadth of one of the six *Felloes*, which serve for the Round of the Wheel of a Gun-Carriage, and fixed on the Circumference of the Wheel with strong Nails, which are called the *Straik-nails* ; these *Straiks* cover the Joints of the *Felloes*, and defend the Wheel.

STRAIT, or *Streight*, in *Hydrography*, is a narrow Sea shut up between Lands on either Side, affording a Passage from one great Sea into another, as the *Strait of Magellan*, the *Strait of Gibraltar*, &c.

STRAKE, in the Sea-Phrase, is a Seam between two Planks ; as the *Garboard-strake* is the first Seam next the Keel. They say also a Ship heels *a-strake*, that is, hangs or inclines to one Side, the Quantity of an whole Plank's Breadth.

STRAND and *Stream*, old Customs, a Freedom from all Impositions upon Goods or Vessels by Land or Sea.

STRANGER, in *Law*, a Person who is not Privy or Party to an Act. As a Stranger to a Judgment, is he to whom a Judgment does not belong ; and in this Sense it is directly opposite to Party or Privy.

STRANGURY, is a Difficulty of Urine, when the Urine comes away by Drops only, accompanied with a constant Inclination of making Water.

STRAP, in a Ship, is the Rope which is spliced about any Block, and made with an Eye to fasten it any where on occasion.

STRATA. Dr. *Woodward*, in his Natural History of the Earth, observes (and that very truly) that the far greatest Part of the Terrestrial Globe consists, from its Surface downwards to the greatest Depth we ever dig or mine, of several *Layers*, or *Strata*, of different kinds of Earthy Matter lying one over another, without any regular Order. This Disposition of the Earth into these *Strata*, had been before observed by *Steno* ; but the Observations and Deductions that Dr. *Woodward* made from them, are wholly new, very numerous, and of great Importance.

STRATARITHMETRY, [of *στρατός*, an Army, *αριθμός*, Number, and *μετρί*, to measure, or account] is the Art of drawing up an Army, or Battalion of Men, according to any Geometrical Figure assigned : And also of expressing the just Number of Men contained in such a Figure, as they stand in Array, either near at Hand, or at a Distance.

STRA-



**STRATIFICATION**, or *Stratum super Stratum*, as the Chymists call it, is putting different Matters *Bed upon Bed*, or one Layer upon another, in a Crucible, in order to calcine a *Metal* or *Mineral*. Thus in *Cementation* (which see) there is first laid a Bed of Cement, then a Plate of Gold; then another Layer of Cement, and then another Plate of Gold; and this is done alternately, till the Crucible is full; which the Chymists would express by saying, *Stratify* Gold and Cement in a Crucible.

**STREAM**, *Works* in the *Tin-mines*, certain Works where the Tanners follow the Veins of Metal, by cutting Trenches, &c.

**STREAM-Anchor**, is only a small one made fast to a *Stream-Cable* for a Ship to ride by in gentle Streams, and in fair Weather, when they would only stop a Tide.

**STRETCH**; when at Sea they are going to *Hoise the Yard*, or *Hale the Sheet*, they say, *Stretch forwards the Hale-Yards* or *Sheets*; meaning that the part which the Men are to Hale by, should be put into their Hands, in order to their Hoising or Haling.

**STRICTOR**, in *Anatomy*, the same as *Sphincter*.

**STRIÆ**, are the Lifts or Rays which run between the *Flutes*, *Channels* or *Striges*, in Fluted Pillars. There are 20 in the Dorick, and 24 in the Ionick Order.

**STRIÆ**, with the Writers of Natural History, are the small *Hollows*, *Channels* or *Chamferings*, which are found in the Shells of Cockles, Etcallops, and other Shell-Fishes.

**STRIKE**, a Sea-word variously used: When a Ship in a Fight, or in meeting with a Man of War, lets down or lowers her Top-sails, at least half Mast high, which they call striking the Top-sails upon the Bunt, they say, she *Strikes*, meaning, she yields or submits, or pays her Devoir to that Man of War as she passes by. When a Ship touches Ground in shoal Water, they say also, she *Strikes*. When a Top-mast is to be taken down, the Word is, *Strike the Top-mast*: And when any thing is let or *lowered*, as they call it, down into the Hold, they call it Striking down into the Hold.

**STRIKING Wheel**, in a Clock, is that which by some is called the *Pin-wheel*; because of the *Pins* which are placed upon the Round or Rim (which in Number are the *Quotient* of the *Pinion* divided by the *Pinion* of the *Detent-wheel*.) In 16 Days Clocks, the *first* or *great Wheel* is usually the *Pin-wheel*; but in Pieces that go 8 Days, the *second* Wheel is the *Pin-wheel* or *Striking-wheel*.

**STRUCTURE**, is the Combination or Result of all those Qualities or Modifications of Matter in any Natural Body, which distinguish it from others, and are what in other Words, is called the peculiar *Form* or *Texture* of it.

**STRUMA**. See *Scrophula*.

**STRUT**, is a Term used by some Builders for that *Brace*, which is framed into the *King-Piece* and the *principal Rafter*s.

**STUDDING-SAILS**, in a Ship, are Bolts of Canvas, or any Cloth that will hold Wind, extended in a fair Gale of Wind along the side of the Main-sail, and boomed out with a Boom; they are sometimes also used to the Clew of the Main-sail, Fore-sail and Sprit-sail, when the Ship goes either before the Wind, or Quartering.

**STUCCO**: Painting in *Stucco* was revived from the Ancients by *Giovanni d' Udine*, a Scholar of *Raphael's*; he found the true Matter which the Ancients made use of, which was a Composition of Lime and Marble powder'd very fine.

**STUPEA**, *seu Stupa*, is a piece of Linnen dipt in a Liquor, and applied to the part affected.

**STUPOR**, in *Medicine*, a Numbness, occasioned by any accidental Bandage that stops the motion of the Blood and nervous Fluids; or, by a decay of the Nerves, as in the Palsy.

**STYGIAN**, *Liquors*, in *Chymistry*, acid Spirits, so called from their Efficacy in destroying or dissolving mixt Bodies.

**STYLE**, so the Botanists call that middle prominent part of the Flower of the Plant, which adheres to the Fruit or Seed: 'Tis usually long and slender, whence its Name of *Stylus*.

**STYLE**, in Dialling, is that Line whose Shadow on the Plane of the Dial, shews the true Hour-line. This is always supposed to be a Part of the Axis of the Earth, and therefore must always be so placed, as that with its two extreme Points it shall respect the two Poles of the World, and with its Upper-end, the elevated Pole. This Line is the upper Edge of the Cock, Gnomon, or Index.

**STYLE**, in *Surgery*, is a long Steel Instrument, that goes diminishing towards one End, so as to be of a conical Figure.

**STYLE**, in *Musick*, is the manner of Singing and Composing.

**STYLO Recitativo**, in *Italian* Musick, a Style fit to express the Passions, called also *Dramatico*.

**STYLO Moteórico**, in *Musick*, a various, rich, florid Style, capable of all kinds of Ornaments, and of Consequence fit to express various Passions, especially, Admiration, Grief, &c. *Ital.*

**STYLO Madrigalesco**, is a Style proper for Love and the softer Passions. *Ital.*

**STYLO Hyperchematico**, is a Style proper to excite Mirth, Joy, Dancing, &c. and of Consequence full of brisk gay Motions. *Ital.*

**STYLO Symphonico**, a Style fit for Instrumental, which is as various as there are symphonical Instruments.

**STYLO Melismatico**, a natural, artless Style, which almost any Body may sing.

**STYLO Phantastico**, a free, easy, humorous manner of Composition, free from all Constraint, &c.

**STYLO Choraico**, is a Style proper for Dancing, and is divided into as many different kinds, as there are Dances.

**STYLE**, in *Chronology*, is a particular manner of accounting Time, with respect to the Retrenchment of ten Days from the Kalendar, in the Reformation made of it in the Time of Pope Gregory XIII.

**Old STYLE**, is the Manner of reckoning *Julian* STYLE, or computation used in *England*, and some other Protestant States, who refus'd to admit of the Reformation.

**Old STYLE**, is the Style that is generally *Gregorian* STYLE, used in most Countries in *Europe*, followed by the *Roman Catholics* in consequence of that Reformation.

Hence there arose a difference of ten Days between the old Style and the new, the *Gregorian* being so much before hand with the *Julian*; so that when they reckoned the 21st of any Month, we reckoned but the 11th. This difference of ten Days was in the Year 1707 increased to 11 Days, by reason that Year was not the Bissextile in the *Old Style*, but was in the new, so that the 10th Day of the one corresponded to the 21st of the other.

**STYLOBATA**, in Architecture, is the Pedestal of a Column or Pillar [*στυλοβάτης* Gr.]



**STYLOBATON**, or *Stylobata*, in Architecture, is the same with the Pedestal of a Column. This is sometimes taken for the Trunk of the Pedestal, between the Cornice and the Base; and then called *Truncus*, as it is also by the Name of *Abacus*.

**STYLOCERATOHYOIDES** [of *στυλο*, a Pillar, *κερα*, a Horn, and *υοειδης*, Gr.] are Muscles of the *Os Hyoides*; which draws upwards the Tongue and Larynx, as also the Jaws in Deglutition, whereby the Masticated Aliment is not only compressed into the latter (the Fauces being then dilated) but the Epiglottis is also depressed, and adequately covers the *Rimula* of the *Larynx*, by its Application to it; by which means the descent of the least part of the Aliment into the *Aspera Arteria* is hindered; which is a most wonderful Mechanism.

They arise from the outward Appendix of the *Os Styloforme*, and are extended to the Horns or Points of the *Os Hyoides*. The middle Tendon of the *Digastricus* of the Lower-Jaw is transmitted through it. 'Tis called also *Stylohyoidæus*.

**STYLO-Chondrohyoidæus**, vel *Stylo-Hyoides alter*, is a Muscle of the *Os Hyoides*; which arises fleshy and tendinous from the *Styloid Process*, near the Origin of the *Stylopharyngæus*, and runs under the *Cerato-Glossus*. It is inserted into the cartilaginous Appendix of the *Os Hyoides*; and its Use is to assist the *Stylo-Hyoidæus*, in putting the *Os Hyoides* upwards and laterally. Dr. Douglass.

**STYLO-Hyoidæus**, is a Muscle of the *Os Hyoides*, arising by a round Tendon from near the middle of the *Processus Styloformis*, and is inserted tendinous into the Basis of the *Os Hyoides*, near its *Cornu*; to which also it often adheres fleshy. Its Use is to put the Bone of the Tongue on one side, and a little upwards, when both act in Concert.

**STYLOEIDES** [of *στυλοειδης*, Gr.] are Processes of Bone fashion'd backward like a Pencil fastned into the Basis of the Skull it self.

**STYLOGLOSSUM** [of *στυλο* and *γλωσσα*, Gr. the Tongue,] is that Pair of Muscles which lift up the Tongue. They arise from the Appendix of the *Os Styloforme*, and are inserted about the middle of the Tongue.

**STYLOHYOIDÆUS**. See *Styloceratohyoides*.

**STYLOPHARYNGÆUS** of [*στυλο* and *φαρυγξ*, Gr. the Gullet] is a Pair of Muscles placed at the Foot of the *Processus Styloides*, that dilate the Gullet, and draw the *Fauces* upwards. They descend from an Appendix of a Bone in fashion of a Pencil, and which reaches the Sides of the Gullet.

**STYMMA** [*σύμμα*, Gr.] is that thick Mass which remains after the steeping of Flowers, Herbs, &c. and pressing out their Oil. Blanchard.

**STYPTICK** [*στυπτικος*, Gr.] Blood-stopping, the same thing with Astringents in the general, which see.

**STYPTICK-Water** of Mr. Lemery, is made of Colcothar, Burnt-Allum, Sugar-candy, of each half a Dram; the Urine of a young Man and Rose-water, of each half an Ounce; Plantane-water, two Ounces: Mix all in a Mortar, and let it stand on the Sediment in a Vial; and when you would use it, pour off the clear Water by Inclination: 'Tis of very good Use to stop Bleeding.

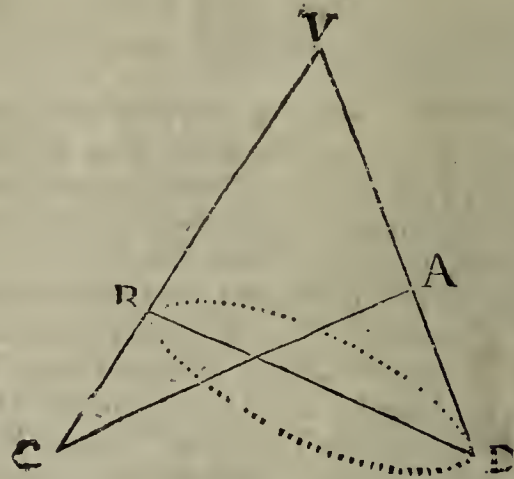
**SUBALTERN Propositions**, are such as differ only in Quantity, and agree in Quality; as every Triangle is Right-Angled, some Triangles are Right-Angled.

**SUBCARTILAGINEUM**. See *Hypochondrium*.

**SUBCLAVIAN-Vessels**, are the Veins and Arteries that pass under the *Clavicles*.

**SUBCLAVIS**, is a Muscle of the *Thorax*, which arises from the inferior Part of half the *Clavicula*; next its connexion with the *Spina Scapulæ*; hence its Fibres descend obliquely forwards to its Insertion at the superior Part of the first Rib near the *Sternum*. Its Use, according to *Spygelius*, who has written a Chapter expressly about this Muscle, is to depress the *Clavicula*.

**SUBCONTRARY Position** (in Geometry) is when two similar Triangles are so placed as to have one common Angle V at the Vertex, and yet their Bases not parallel.



And therefore if the Scalenois Cone B V D be so cut by the Plane C A, as that the Angle at C = D: The Cone is then said to be cut *Subcontrarily* to its Base B A. See *Spherick Geometry*, where such a Section of a Cone is demonstrated to be a Circle.

**SUBCONTRARY Propositions**, are such as particularly differ in Quality, and agree in Quantity; as, *some Man is a Creature, some Man is not a Creature*.

**SUBCUTANEUS**, a Branch of the *Basilica*, running towards the inner Condyle of the Arm. It divides into *Ramus Anterior*, and *Posterior*, which see.

**SUBDUCTION**, the same with *Subtraction*; which see.

**SUBDUPE Proportion**, is when any Number or Quantity is contained in another twice; Thus 3 is said to be *Subdupe* of 6, as 6 is double of 3.

**SUBETH Avicennæ**. See *Coma*.

**SUBJUNCTIVE Mood** (in Grammar) so called, because it has always some Condition annexed to what we affirm, and so is subjoined to, or conjoined with some other *Verb*.

**SUBLUXATION**, a Dislocation, or putting out of Joint.

**SUBLIMATE Corrosive**, is a Preparation in Chymistry, whereby Mercury is impregnated with Acids, and then sublimed up to the top of the Vessel: Thus performed;

Pour on a Pound of good running Mercury, 18 Ounces of Spirit of Nitre; set the Matrafs in Sand a little warmed, till the Mercury be all dissolved; evaporate the Dissolution in a Glass, or Earthen Pan, till all the Moisture be carried off; and then powder the remaining white Mass in a Glass-Mortar, and then mix with it a pound of Vitriol calcined white, and so much Salt decrepitated: Put this Mixture into a Matrafs, whose two Thirds at least remain unfilled; set the Vessel in Sand, and begin with a small Fire for three Hours; after which, that Fire must be encreased to a good Strength: The Sublimate will adhere to the top of the Matrafs, and



and there will be a Pound and three Ounces of it. The red *Scories* at the Bottom are useles. 'Tis a more violent Escharotick than the *Lap's Infernalis*, and inwardly taken, is one of the strongest Poisons in the World. Of this is made *Mercurius Dulcis*. The Druggists sometimes sell a Sort of it that is made of *Arsenick*; but you may easily discover it, by rubbing it with a little Salt of Tartar, for then it will turn *Black*; but if it turn *Yellow*, it is good.

**SUBLIMATION**, an Operation in Chymistry, whereby the finer and more *subtile* Parts of a mix'd Body are separated from the rest, and carried up in the Form of a very fine Powder to the Top of the Vessel. These Powders they call *Flowers*, as *Flowers of Brimstone*, of *Benjamin*, &c. the Vessels that serve for these Uses, are called

**SUBLIMING Pots**, or *Aludels*; which Word see.

**SUBLIMIS**, one of the Muscles which bend the Fingers.

**SUBLINGUALES**, are Glands, one on each Side of the Tongue; they have two Excretory Ducts (as the *Maxillares*) form'd by the Union of that of each small Gland; they run on each Side of the Tongue, near its Tip, where they open into the Mouth at a little Distance from the Gums; when the *Mylohyoides* acteth, it compresses them

**SUBLINGUINUS**, is the same with *Epiglottis*, or *Pion*; which see.

**SUBLUNARY**, all things that are in the Earth, or in the Atmosphere thereof, below the Moon.

**SUBMULTIPLE Number**, or Quantity, is that which is contained in another Number, a certain Number of times exactly: Thus, 3 is Submultiple of 21, as being contained in it seven times exactly.

**SUBMULTIPLE Proportion**, the Reverse of Multiply; which see.

**SUBNORMAL**; is a Line, determining in any Curve, the Interfection of the Perpendicular to the Tangent in the Point of Contact, with the Axis. And this Subnormal, in the common or *Apollonian* Parabola, is a determinate invariable Quantity; for 'tis always equal to half the *Parameter* of the Axis.

**SUBORNATION**, is a secret or under-hand preparing, instructing, or bringing in a false Witness, or corrupting or alluring to do such a false Act. Hence the *Subornation of Perjury*, mentioned in the Act of *General Pardon*, 12 Car. 2. Cap. 8. is the Alluring to Perjury.

**SUBPOENA**, is a Writ whereby all Persons, under the Degree of Peerage, are called into *Chancery*, in such Case only where the Common Law fails, and hath made no Provision, so as the Party who in Equity hath Wrong, can have no ordinary Remedy by the Rules and Course of the Common Law: But Peers of the Realm, in such Cases, are called by the Lord-Chancellor's, or Lord-Keeper's Letters, giving notice of the Suit intended against them, and requiring them to appear.

There is also a *Subpœna ad testificandum*, for the summoning of Witnesses, as well in *Chancery* as other Courts.

There is also a *Subpœna* in the *Exchequer*, as well in the Court of Equity there, as in the Office of Pleas.

And these Names proceed from the Words in the Writ, which charge the Party summoned to appear at the Day and Place assigned, *sub Pœna centum Librarum*.

**SUBSCAPULARIS**, or *Immerfus*, is a Muscle of the Arm, so named from its Situation; by some called *Immerfus*. It is a large fleshy Muscle, filling the Internal concave Part of the *Scapula*; arising fleshy from its whole *Basis*, and *Superior* and *Inferior Costa* internally, and marcheth forward, lessening itself according to the Dimensions of the Bone; and passing over the Juncture, is inserted in a semicircular manner to the Neck of the *Os Humeri*. When this acteth, the *Os Humeri* is pulled near the Trunk of the Body. The Tendon of this Muscle, together with the *Supra* and *Infra Spinaus*, and *Teres Minor*, unite near their Insertions, and environ the Articulation of the *Os Humeri* with the *Scapula*, not unlike the *Ligamentum Catum* of the *Coxa*, to prevent frequent Luxations: And by their successive alternate acting, the Arm is moved circularly.

**SUBROGATION**, in the Civil Law, is putting another Person into the Place and Right of him, that, in any Case, is the proper *Creditor*. This is also called *Cession*.

**SUBSIDY**, in Law, signifies an Aid, Tax, or Tribute granted by Parliament to the King, for the urgent Occasions of the Kingdom, to be levied of every Subject, according to the Rate of his Lands or Goods, as the Parliament shall think fit.

**SUBSTANCE**, is whatever subsists by it self independently from any created Being; and which is the Subject of Accidents and Qualities.

**SUBSTANTIA Corticalis Cerebri**. See *Cortical* or *Cineritia*.

**SUBSTANTIVES**, in Grammar, are such Words as describe the absolute Being of a Thing, and which joined with a Verb, do make a perfect Sentence.

**SUBSTITUTE**, in Pharmacy, a Drug or Medicine that may be used instead of another.

**SUBSTITUTION**, is, in Algebra or Fluxions, the putting in the room of any Quantity in an Equation, some other Quantity which is really equal to it, but express'd after another manner; and this is done in order to find, at least, such a proper Expression in the Equation, as shall solve the Problem, or Question proposed. And in the Knack of doing this readily, consists the chiefest Business of the Operations in Fluxions.

**SUBSTYLAR Line**, in Dialling, is that Line drawn on the Plane of the Dial, over which the Style stands at Right Angles with the Plane. This is always the Representation of the Meridian of that Place where the Plane of the Dial is Horizontal. The Angle between the Line, and the true Meridian, is the Plane's Difference of Longitude, and is measured on the Equinoctial.

**SUB-SUPER particular Proportion**, is contrary to *Super-particular* Proportion; which see.

**SUB-TANGENT**, in any Curve, is the Line which determines the Interfection of the Tangent in the Axis. And in any Equation, if the Value of the Sub-tangent come out *Positive*, 'tis a Sign that the Point of Interfection of the Tangent and Axis, falls on that Side of the Ordinate where the Vertex of the Curve lies; as in the *Parabola* and *Paraboloids*. But if it come out *Negative*, the Point of Interfection will fall on the contrary Side of the Ordinate.



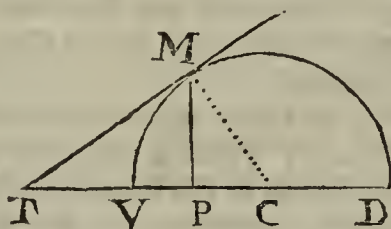
Ordinate, in respect to the Vertex, or beginning of the Abscissa; as in the *Hyperbola*, and *Hyperboliform Figures*.

And universally, in all *Paraboliform* and *Hyperboliform Figures*, the *Sub-tangent* is equal to the *Exponent of the Power of the Ordinate multiplied into the Abscissa*.

Thus, in the common Parabola, whose Property is  $p x = y y$ , the Sub-tangent is in Length equal to  $x$ , the Abscissa multiplied by 2, the Exponent of the Power of  $y y$ , the Square of the Ordinate; that is, 'tis equal to twice the Abscissa; and by the former Rule for Paraboliform Figures, it must be taken above the Ordinate in the Axis produced. Thus also in one of the cubical Paraboloids, where  $p x x = y y y$ , the Length of the Sub-tangent will be half of the Abscissa.

Thus, in the Figure annexed, you will see that the

**SUB-TANGENT**, in any Curve, is a Line which determines the Intersection of the Tangent



in the Axis. Thus, if  $T M$  be a Tangent in the Point  $M$ , and  $P M$  an Ordinate to the Axis, the  $T P$  is the Sub-tangent, because it determines the Point  $T$ , where the Tangent cuts the Axis produced beyond the Vertex of the Curve  $V$ . And the Line  $P C$ , which determines the Intersection of the Perpendicular  $M C$  (to the Tangent in the Point of Contact  $M$ ) in the Axis  $V D$ , is called the *Sub-normal*.

**SUBTENSE**, or Chord of an Arch, is a Right Line extended from one End of that Arch to the other End thereof.

**SUBTERRANEAN**, or *Subterranean*, is whatever is within the Surface, Bowels, or Caverns of the Earth. Thus those Trees, which being left there at the Universal Deluge, are so plentifully found buried in the Earth in many Countries, are called *Subterranean Trees*, and by some, *Fossile Wood*.

**SUBTILE**, in *Physick*, exceeding small, fine and delicate, such as the Animal Spirits, &c. the Effluvia of Odorous Bodies, &c. are supposed to be.

**SUBTILIZATION**, the Art of *subtilizing*, or rendring any thing smaller and *subtiler*, particularly, the dissolving or changing a mix'd Body into a pure Liquor, or a fine Powder.

**SUBTRACTION**, in the general, is taking a lesser Quantity from a greater, to find the Difference between them, which is commonly called the *Remainder*; as the lesser Quantity to be subtracted is called the *Subtrahend*. The General Sign or Mark of Subtraction is —

**SUBTRACTION**, in *Algebra*, or in Species, conjoins the Magnitudes proposed, changing all the Signs of the *Subtrahend*.

Thus: If from  $4 a$ , you subtract  $a$ , by changing the Sign of the *Subtrahend*, it will stand thus:

$$\begin{array}{r} 4 a \\ - a \\ \hline X = 3 a \end{array}$$

Or thus,

$$4 a - a = 3 a.$$

And in Algebra, the Remainder, or Difference, is usually noted by the Letter  $X$ , or  $d$ .

*N. B.* To subtract  $+$ , is the same as to add  $-$ , and to subtract  $-$ , is all one as to add  $+$ ; as is plain from the Reasons given in Addition in Algebra; which see.

Algebraick Subtraction, in Compound Quantities, will easily be performed by only observing the General Rule of changing the Signs of the Quantity to be subtracted, and then comparing the several Members together, and contracting them.

As suppose from  $36 b + 5 m m - 7 d f$ , you would subtract  $20 b + 2 d f + 5 m m$ . Write them down one under another, changing all the Signs of the *Subtrahend*, and it will stand thus:

$$\begin{array}{r} 36 b + 5 m m - 7 d f \\ - 20 b - 5 m m - 2 d f \\ \hline 16 b - 9 d f = X \end{array}$$

Which compared and contracted, will give the Difference or Remainder.

**SUBTRACTION of Indices**, is done as Algebraical Quantities are, by changing the Sign of the *Subtrahend*: Thus,

From  $3$  take  $2 = 5$ , from  $3$  take  $2 = 5$ ,  
from  $3$  take  $2 = 1$ , from  $3$  take  $2 = 1$ .

**SUBTRACTION of Integers**, in *Common Arithmetick*, is performed by subscribing the lesser Number under the greater, orderly, so that Units stand under Units, Tens under Tens, &c. and then beginning at the Place of Units at the Right Hand, take the lesser from the greater, writing down the Remainder under the Line: If nothing remain, write down a Cypher, or  $0$ . If the upper Number be in any Part (for it cannot be so in the whole) lesser than the lower, add ten to it, or call it ten more than it is, writing down orderly the Excess above Ten; and then be sure to carry that Ten so borrowed, to the next Figure, calling it one more than it is, and so on, as the following Examples.

|      |       |       |       |        |
|------|-------|-------|-------|--------|
|      | 18    | 756   | 8254  | 567438 |
|      | 15    | 431   | 6332  | 358784 |
|      | <hr/> | <hr/> | <hr/> | <hr/>  |
| Rem. | 3     | 325   | 1922  | 208654 |
|      | <hr/> | <hr/> | <hr/> | <hr/>  |



In *Subtraction*, the Number to be subtracted, together with the Difference or Remainder, are equal to the Number from which the Subtraction was made, which is a good Proof for Subtraction; as in the third Example, 6332, and the Remainder 1922, makes 8254, the first Number.

But if the Numbers be of different Denominations, then 'tis but taking the lower Denomination from that above it, and setting down the Remainder: But if any of the upper Denominations be lesser than their respective lower ones, then you must borrow one of the former Denominations next to the Left Hand, and subtract, remembring to add 1 to the next Denomination below. As in the following Examples.

| <i>l.</i> | <i>s.</i> | <i>d.</i> | <i>l.</i> | <i>s.</i> | <i>d.</i> |
|-----------|-----------|-----------|-----------|-----------|-----------|
| 375       | 11        | 05        | 1754      | 11        | 02        |
| 132       | 09        | 04        | 982       | 13        | 05        |
| <hr/>     |           |           | <hr/>     |           |           |
| 243       | 02        | 01        | 771       | 17        | 09        |
| <hr/>     |           |           | <hr/>     |           |           |

Here the first Example has nothing of Difficulty in it; for the Lower is in each Denomination lesser than its Upper.

In the second Example, since 5 *d.* cannot be taken out of 2 *d.* I borrow 12 *d.* and 'twill be 14 *d.* Then I say, 5 from 14 leaves 9, which I set below: Now the 12 *d.* I borrowed must be added to the 13 *s.* on the Left Hand, then 'twill be 14 *s.* which I subtract from 31 (borrowing 20) rests 17: Then, as in whole Numbers, 3 from 4 leaves 1, &c.

*SUBTRACTION of Logarithms.* See *Logarithms*, N. 4.

*SUBTRACTION of Vulgar Fractions.* See *Vulgar Fractions*.

*SUBTRACTION of Decimal Fractions.* See *Decimal Fractions*.

*SUBTRIPLE Proportion*, is when one Number or Quantity is contained in another three times: Thus 2 is said to be *Subtriple* of 6, as 6 is *Triple* of 2.

*SUBURBICARIÆ Regionēs*, called also *Suburbanæ*, *Urbicariæ vicinæ*; were such Regions or Cities of the Roman Empire as lay within an hundred Miles of Rome, and were under the Jurisdiction of the *Præfect* of that City: Wherefore they are sometimes called *Regionēs Solitæ*, because in these the Governour of Rome was wont to exercise his solemn Jurisdiction. This also was the ancient Extent of the Power and Charge of the Bishops of Rome, before the Papal Usurpation.

*SUCCEDANEUM*, in *Pharmacy*, a Medicine substituted in the Place of another first prescribed, when the other Ingredients prescribed are not to be had.

*SUCCENTURIATI Renes.* See *Capsulæ atrabiliaria*.

*SUCCESSION*, in *Philosophy*, is that Idea which we get by reflecting on that Train of Ideas constantly following one another in our Minds when awake.

*SUCCESSION of the Signs*, is that Order in which they are usually reckoned: As first *Aries*, next *Taurus*, then *Gemini*, &c. This is otherwise called *Consequence*.

*SUCCOTRINE Aloes*, is the finest Sort that comes from the Island *Succotra*, on the Coast of *Arabia*, and from its Colour is called, *Aloes Hepatica*, or Liver-colour'd Aloes.

*SUCCUS Pancreaticus.* See *Ductus Pancreaticus*.

*SUCTION*; there are many Effects vulgarly attributed to *Suction*, which, in reality, have very different Causes. As when any one sucks Water, or any other Liquor, up through a Pipe, 'tis commonly thought, that by that Action the Person draws the Air up into his Mouth, and that the Water, which is contiguous to it, follows it by a kind of *Attraction*, as if the Air and Water hung together: And others fancy, that the Air moves into the Mouth of the *Sucker*, and the Water moves up after the Air, to prevent a *Vacuum*, which they say, *Nature abhors*. Whereas the true Cause of this Phænomenon, is only that the Air and Atmosphere presses with its whole Weight, uniformly on the Surface of the Liquor in the Vessel, and consequently prevents any one Part of the Water to rise higher than the other there: And if a Pipe be put in of any tolerable large Bore, and be open at both Ends, the Water will rise within the Pipe to the same Height as without, and indeed a little higher, because of the Pressure of the Air within the Pipe is a little taken off by bearing against the Sides of the Pipe. Now when any one applies his Mouth to the upper End of the Pipe and sucks, his Lips so strongly enclose the Pipe, that no Air can get between them and it; and by the voluntary Motion of the Spirits in the Muscles, the Cavity of his *Thorax*, or Breast, is opened and enlarged; by which means the Air included there, hath now a much larger Space to dilate itself in, and consequently cannot press so strongly against the upper End of the Pipe, as it did before the Cavity of the *Thorax* was so enlarged, and when the Weight of the whole Atmosphere kept its Spring bent. And that Weight or Pressure being now taken off by the Lips of the Man that sucks, the *Æquilibrium* is destroyed, the Air gravitates on the Surface of the Water, but cannot do so on the upper Orifice of the Pipe, because the Junctionure of the Lips takes it off; and the Spring of the Air included in the *Thorax*, being weakened by the Dilatation of its Cavity, it cannot press so hard against the upper Orifice of the Pipe, as the Water will do against the lower, and consequently the Water must be forced up into the Pipe. 'Tis much the same thing in the Suction of a common Pump: The Sucker being tight, takes off entirely the Pressure of the Atmosphere on the Surface of the Water within the Barrel of the Pump; and consequently the Atmosphere, by its Weight, must force the Water up to make the *Æquilibrium*. See *Hydrostaticks*.

*SUCULA*, or *Succula*, is a Term in Mechanics for a bare Axis, or Cylinder, with Staves in it to move it round, but without any Tympanum, or *Peritrochium*.

*SUDAMINA*, are little Pimples in the Skin, like Millet Grains; this is frequent in Children and Youths, especially those that are of a hot Temper, and use much Exercise: They break out in the Neck, Shoulders, Breast, Arms and Thighs, &c. *Blanchard*.



**SUDOR**, *Sweat*, is a watry Humour which consists of Water chiefly, with a moderate Quantity of Salt and Sulphur. This is driven through the Pores of the Skin by the Heat and Fermentation of the Blood, and sometimes by its Weakness and Colliquation. *Blanchard*.

**SUDORIFICKS**. See *Hydroticks*.

**SUFFITUS**, is a thickish Powder prepared of odoriferous Plants, Gums, &c. which thrown upon Coals, produces a pleasant Smell. *Blanchard*.

**SUFFOCATIO Uterina**. See *Hysterica passio*.

**SUFFRAGAN**, is a titular Bishop appointed to aid and assist the Bishop of the Diocesis, and by 36 Hen. 8. c. 14. every Bishop is empowered to elect two honest and discreet Spiritual Pastors, which shall be called *Bishops Suffragans*.

**SUFFRUTEX**, is a Name by the *Botanists* given to a low woody perennial Plant, sending out no Leaves from its Root, and beginning to be branched from the very Bottom of the Stalk; such as *Lavender, Rue, Sage, &c.*

**SUFFUMIGATION**, in *Physick*, a Term applied to all such Remedies as are received into the Body in the Form of Fumes.

**SUFFUSION**. See *Hypochyma & Cataract*.

**SUGAR of Lead**. See *Salt of Saturn*.

**SUIT**, signifies a following another, but in diverse Senses.

The first, is a *Suit in Law*, and is divided into *Real and Personal*, and is all one with *Action Real and Personal*.

Secondly, *Suit of Court*, or *Suit-service*, is an Attendance that Tenants owe to the Court of their Lord.

Thirdly, *Suit-Covenant*, is when your Ancestor hath covenanted with mine *to sue* to his Court.

Fourthly, *Suit-Custom*, when I and my Ancestors have been seized of their own and their Ancestors *Suit*, Time out of Mind.

Fifthly, *Suit Real or Regal*, when Men come to the Sheriffs Turn or Leet.

Sixthly, *Suit* signifies the following one in Chace, as *Fresh-suit*.

Lastly, it signifies a Petition made to the King, or any great Person.

**SUIT of the King's Peace**, is pursuing a Man for Breach of the *King's Peace* by Treasons, Insurrections or Trespasses.

**SULPHUR**, the second Hypostatical Principle of the Chymists, which we call Oil. See *Oil*.

The Constituent Character of Sulphur seems to be *Inflammability*: And there are three kinds of Inflammable Bodies obtainable by Chymistry.

First, *An Oil*.

Secondly, *An Ardent Spirit*.

Thirdly, *A Consistent Body*, like to common Brimstone: All which are properly Sulphur.

**SULPHUR**. Sir *Isaac Newton*, on very good Grounds, concludes, that the common Sulphur is composed of volatile and fixed Parts, strictly adhering to one another by mutual *Attraction*, so that they will both sublime together; for by dissolving

Flowers of Sulphur in Oil of Turpentine, and then distilling the Dissolution, 'tis found, that Sulphur consists of a thick, volatile and inflammable Oil, or of a fat *Bitumen*, an *acid Salt*, and a very fixed Earth, with a little Metal. The three first of which are found there in nearly an equal Quantity; but there is only a very small Proportion of the last. The *acid Salt* being dissolved in Water, is the same with the *Oleum Sulphuris per Campanam*.

**SULPHUR VIVUM**, is Sulphur as it is taken out of the Mine. It is a Sort of greyish argillous Clay, which easily takes Fire, and in burning sends forth a strong sulphureous Smell.

*Mineral* **SULPHUR**, is a kind of hard, earthy *Bitumen*, of a shining yellow Colour, a strong, stinking Smell, easily taking fire, and dissolving.

*Magistry of* **SULPHUR**, in *Chymistry*, is Sulphur dissolved in a sufficient Quantity of Water, with Salt of *Tartar*, and precipitated by means of a Spirit of Vinegar, or some other Acid. Called also *Milk of Sulphur*, on account of its *Whiteness*, and *Balm of Sulphur*, on account of its Balsamick Quality to the Lungs and Breast.

**SULPHUR of Antimony**. See *Golden Sulphur of Antimony*.

**SULPHUREOUS Spirit of Vitriol**. After the Spirit and Oil of Vitriol are in Distillation of that Mineral, driven out by a most violent Fire (for three or four Hours together) into the Receiver, they commonly rectify the Matter in a Glass Body, and the first Spirit that rises then with a very gentle Degree of Fire, is called the *Sulphureous Spirit of Vitriol*.

**SUM**, in *Mathematicks*, signifies the Quantity that arises or results from the Addition of two or more Magnitudes, Numbers or Quantities together; this is sometimes called the *Aggregate*: And in Algebra 'tis usually denoted by the Letter Z, which stands for *Zuma* or *Suma*; and sometimes by the Initial Letter S.

**SUM of an Equation**, is when the absolute Number being brought over to the other Side with a contrary Sign, the whole becomes equal to O. And this *Des Cartes* calls the *Sum of the Equation proposed*.

**SUMMATORY Calculus**, according to some is the same with the *Calculus Differentialis* of *Leibnitz*; but more properly *Summatory Arithmetick*, is the Art of finding the flowing Quantity from the Fluxion; and so it is the same with the *Calculus Integralis*. See *Hayes's Fluxions*.

**SUMMER Solstice**. See *Solstice*.

**SUMMER**, in *Architecture*, is a large Stone, the first that is laid over Columns and Pilasters, in the beginning to make a cross Vault; or it is the Stone, which being over a Piedroit, or Column, is hollowed to receive the first Haunce of a Platanband.

**SUMMER**, in *Carpentry*, a large Piece of Timber, which being supported upon two Stone Peers, Stones, or Posts, serve as a Lintel to a Door, Window, &c.

**SUMMONEAS**, is a Writ Judicial of great Diversity, according to the diverse Cases wherein it is used, which see in the Table of the *Register Judicial*.

**SUMMONER**, or *Summonitor*, an Apparitor, who is to cite in Offenders to appear at a certain Time and Place, to answer to the Charge exhibited against them.

SUM-



SUMMONS, in *Common Law*, is as much as *Vocatio in Jus*, or *Citatio* among the *Civilians*: But how *Summons* is divided, and what Circumstances it has to be observed. See *Fleta*, lib. 6. Cap. 6, 7.

SUMMONS, in *Terrapetita*, is that Summons which is made upon the Land, which the Party (at whose Suit the *Summons* is sent forth) seeks to have.

SUMMONS *ab Warrantizand*, in Law, is the Process whereby the *Vouchee* is called.

SUMMUM *Bonum*, or the chiefest Good of Human Nature, is that, which by its Enjoyment, renders truly and compleatly happy. The Schools distinguish this chief Good of Man into that which is simply and adequately so, and beyond which there can be no other; and into a lesser and subordinate one, which is in some measure attainable in this imperfect State; and this last they call *Fœlicitas Viatorum*, and the former *Fœlicitas Comprehensivum*.

SUMPTUARY *Laws*, were Laws made to restrain Excess in Apparel, and to prohibit costly Cloaths, of which we had formerly many in *England*, but now are all repealed.

SUN. Our excellent Sir *Isaac Newton* faith in his *Principia*, That the Density of the Sun's Light (which is proportional to Heat) is seven times as great in *Mercury* as with us; and therefore our Water there would be all carried off, and boil away: For he found by Experiments of the *Thermometer*, that an Heat but seven times as great as that of the Sun-Beams in Summer, will serve to make Water boil.

He proves also, that the Matter of the Sun to that of *Jupiter*, is nearly as 1100 to 1; and that the Distance of that Planet from the Sun is in the same Ratio to the Sun's Semidiameter.

That the Matter of the Sun to that of *Saturn*, is as 2360 to 1; and the Distance of *Saturn* from the Sun, is in a Ratio, but a little less than that to the Sun's Semidiameter.

And consequently that the common Centre of Gravity, of the Sun and *Jupiter*, is nearly in the Superficies of the Sun; of *Saturn*, and the Sun a little within it. And by the same manner of Calculation it will be found that the common Centre of Gravity of all the Planets, cannot be more than the Length of the Solar Diameter distant from the Centre of the Sun: This common Centre of Gravity he proves to be at rest; and therefore tho' the Sun, by reason of the various Position of the Planets, may be moved every way, yet it cannot recede far from the common Centre of Gravity. And this he thinks ought to be accounted the Centre of our World. *Book 3. Prop. 12.*

By means of the *Solar Spots* it hath been discovered, that the Sun revolves round his own Axis, without moving (considerably) out of his Place, in about 25 Days. And that the Axis of this Motion is inclined to the Ecliptick, in an Angle of 87 Degrees, 30 Minutes nearly. *Gregor. Astronom.*

The Sun's apparent Diameter being sensibly shorter in *December* than in *June*, as is plain and agreed from Observation, the Sun must be proportionably nearer to the Earth in Winter than in Summer; in the former of which Seasons will be the *Perihelion*, in the latter the *Aphelion*: And this is also confirmed by the Earth's moving swifter in *December* than it doth in *June*; as it doth about  $\frac{1}{15}$ .

For since, as Sir *Isaac Newton* hath demonstrated by a Line drawn to the Sun, the Earth always describes equal Areas in equal Times, when ever it moves swifter, it must needs be nearer to the Sun. And for this Reason, there are about eight Days more from the Sun's Vernal Equinox to the Autumnal, than from the Autumnal to the Vernal.

According to Mr. *Cassini*, the Sun's greatest Distance from the Earth is 22374, his mean Distance 2200, and his least Distance 8022 Semidiameters of the Earth.

And that the Sun's Diameter is equal to 100 Diameters of the Earth, and therefore the Body of the Sun must be 1000000 times greater than that of the Earth.

Mr. *Azout* assures us, that he observ'd by a very exact Method the Sun's Diameter to be not less than 31 Minutes, 45 Seconds in his *Apogee*, and not greater than 32 Minutes, 45 Seconds in his *Perigee*.

The mean Apparent Diameter of the Sun, according to Sir *Isaac Newton*, is 32 Minutes, 12 Seconds; in his *Theory of the Moon*, 32 Minutes, 15 Seconds.

If you divide 360 Degrees (*i. e.* the whole Ecliptick) by the Quantity of the Solar Year, it will quote 59 Minutes, 8 Seconds, &c. which therefore is the Quantity of the Sun's Diurnal Motion. And if this 59 Minutes, 8 Seconds, be divided by 24, you have the Sun's Horary Motion, which is 2 Minutes, 28 Seconds; and if you will divide this last by 60, you will have this Motion in a Minute, &c. And this way are the Tables of the Sun's mean Motion, which you have in the Books of Astronomical Calculation constructed.

The Sun's Horizontal Parallax, Dr. *Gregory* and Sir *Isaac Newton* make but 10 Seconds.

The same learned Mathematician, at the End of his *Astronomiæ Phys. & Geometr. Elem.* hath a Comparative Astronomy, where, among the rest, he considers what Phænomena would appear in the Planetary System, &c. to an Eye placed at the Sun, which are such as these:

1. That the Fix'd Stars would appear in a Concave Sphere, the apparent Centre of which is the Eye of the Spectator.

2. He would distinguish the Planets from the Fix'd Stars (tho' they would appear to him to be placed among them) by their Periodical Revolutions, and by the Time of those, one Planet from another: And he would judge that Planet to be farthest off, whose Periodical Revolution was the longest; and so on in order for the rest, &c.

3. To this Solar Observer's Eye, the Planets would appear always *direct*, and never *stationary*, nor *retrograde*, as they do to an Eye at the Earth: And they would be found to return to the same Fix'd Stars again, as Periods of very different Lengths; and the Inferior Planets would sometimes cover the Superior ones.

4. If you suppose the Eye to be moved from the Centre of the Sun to its Surface, then by the Parallax of the Planets, some better Guess will be had of their Distances, than by the Observation of the different Velocity and Tardity of their Motion, could before be obtained: For to the Eye thus placed the



the Earth's Horizontal Parallax will be 16 Minutes, equal to the Sun's Semidiameter, and consequently sensible enough. That of *Saturn* will be something above one Minute and an half (that Planet being ten times the Distance of the Earth from the Sun; and the Horizontal Parallax of *Mercury* will be almost fifty Minutes: And since these Parallaxes are sufficiently sensible, the Distances of the Planets may be compared with the Sun's Diameter, and with one another.

5. To an Eye thus placed, all the Fix'd Stars and Planets will seem to revolve from East to West, in the Space of 25 of our Natural Days: The North Pole of which Revolution will be in that Part of the Heaven, which we (Inhabitants of the Earth) call the tenth Degree of *Pisces*, with 83 or 84 Degrees of North Latitude: Wherefore the Arctick Pole-Star will be at the second Flexure of *Draco*, and which will not be above three Degrees from the Pole. The South-Pole will be in ten Degrees of *Virgo*, with 83 or 84 Degrees South Latitude, near a Star of the fourth Magnitude, which, in Dr. *Halley's* Catalogue, is in the first Oar of the *Argo Navis*.

6. The Planets thus seen from the Sun will appear of different Magnitudes: For the Diameter of *Saturn* will subtend there but an Angle of 18 Seconds: That of *Jupiter* near 40 Seconds: That of *Mars* but eight Seconds; that of *Venus* 28 Seconds; and the Diameter of *Mercury* 20 Seconds.

But Mr. *Huygens* supposes the Diameters of the superior Planets will be much larger; as making that of *Jupiter* to subtend an Angle of almost 54 Seconds; and that of the Body of *Saturn* without his Ring 27 Seconds.

7. Of these six Planets thus moving round the Sun, three will appear attended with their Satellites: Of which the Earth will have but one, which is the Moon; and who will appear at the greatest Distance, not to be from the Earth above ten Minutes.

*Jupiter* will appear with his four Moons, or Satellites; of which the outermost will never appear above nine Minutes distant from the Primary Planet.

*Saturn* will appear with his five Satellites (if so many there be) and the furthest of them will never be above nine Minutes distant from his Body: His Ring also will appear compassing round the Planet.

The Paths, or Orbits, of these Satellites being seen from the Sun sometimes more, sometimes less Oblique, will appear accordingly now broader, now narrower Ellipses; sometimes the Planes of these Orbits being produced, will pass through the Sun: In which case, the former narrow Ellipses will pass into Right Lines; which will happen twice in every Revolution of the Orbit round the Sun, if its Plane remain always parallel to itself: Whence the Satellite will now appear to be covered by the primary Planet, and then the Planet by it; and sometimes will appear round the Planet, without its Disk, in an Ellipsis.

8. The primary Planets, as also their Satellites, have not only rough and unpolished Surfaces, but

also are so difform, that they have their Spots, which are Places more or less obscure (and sometimes more bright) than the rest of their Disk: And these Spots, by the Rotation of the Planet, or Satellite, round its Axis, do describe Circles; and therefore these Ways, or Paths of the Spots, being seen from the Sun in the Plane of the Planetary Disk, will now appear Elliptical, and now straight Lines (as before the Paths of the Satellites Disk) according as the Sun is elevated on either Side, above the Plane of those Circles, or is found in it, as it is when it is in the Equinoctial of that Planet. And if there be a Series, or Row, of these Spots, (as in the Belts of *Mars* and *Jupiter*) these will appear in the Form of Semi-Ellipses (the one half being behind, or on the other Side the Planes) or will pass into straight Lines, which will also be the Case of the outward Edge of the Ring of *Saturn*. But some of these Spots will now and then be hid, and sometimes be visible for a long time, according as they are near to the Planets Pole, which is turned from or towards the Sun.

And this will be most observable in *Saturn*, and in the Earth, in the others scarcely at all, because in them the Illustration of the Sun reaches to both their Poles.

9. Besides these six primary Planets, and their ten Satellites, which to our Solar Observator will all appear to move within the Bounds of a Zodiac scarce sixteen Degrees broad, and not much inclined to the Circle of the first Motion, all the same way, and in Orbits nearly Concentrical to the Sun: There are also another kind of Bodies, whose Number is uncertain, which move round the Sun in very Eccentric Orbits, and which are called *Comets*; and which sometimes come very near the Sun, and sometimes are vastly remote from him.

These *Comets* do not move all in the same Track (altho' each one always keeps his own) but some one Way, and some another, and mostly in Orbits very much inclined to the Ecliptick, and always in great Circles of the Sphere. Their *Coma*, or Tail (to an Eye at the Sun) will not appear oblong, or stretch'd out in Length, as it doth to us, but every way diffused round the Head.

SUN. Dr. *Hooke*, in *Opera Post.* p. 89. from all his, and others Observations, thinks it reasonable to conclude, that the Superficies of the Sun is covered with an Air or Atmosphere, or some other Fluid Body: And that this Atmosphere, though possibly eighty times thicker and higher than that about our Earth; yet in Comparison of the vast Diameter of the Solar Body, becomes wholly invisible to us, though assisted by the best Telescopes: He supposes it also to look as bright as the Body of the Sun itself, and that it is really the Shell of this Atmosphere, and not the very Body of the Sun that shines. And from hence he saith, that all the Phenomena of the *Maculae* and *Faculae* of the Sun will be solved; and that they are only Clouds or Smoaks in this Atmosphere.

The Sun itself, within this Atmosphere, he concludes to be a Solid and Opacous Body (p. 91.) from these Reasons. 1. The Constancy of its Rotation. 2. The Fixedness of its Axis. 3. The Power of its Gravitation, or Attraction, towards its Centre. These prove its Solidity; and its Opacity, he concludes, from the disappearing of the Solar Spots in the Limb, and their not returning



ing backwards, as they would seem to do if the Body were transparent as the Atmosphere is, or the Flame of a Candle, or the Radiation, or hazy Light about the *Nucleus* of a Comet, through which, as well as through its Beard, the small fixed Stars may be seen.

He thinks the superficial Parts of the Sun to consist of Bodies similar to our Nitre and Sulphur, and that these are set on fire; and consequently, that the Physical Cause of its Light is the actual burning, or Fire of its superficial Parts. Nor can there be any Objection of Moment brought against this Hypothesis, from the Danger of the Sun's Fire being burnt quite out in so many thousand Years as it hath been in being: for (saith he) supposing it to have grown some Minutes less since it began to give Light, none can contradict it by any Observations we have on Record: For, supposing we had Observations Astronomical of 4000 Years standing, as we have none above 2000 of that kind; and allowing that the Sun's Diameter had been then observed to be as many Minutes as it is now, yet could it not be thence concluded, that the Sun did not lose a Mile in Diameter every Year, and consequently be now 4000 Miles less in Diameter than it was then. For since his Diameter is near 87 times greater than that of the Earth; which latter he supposes 8000 Miles, then the Sun's must be 696000 Miles. Now 4000 is but the 174th Part of that Diameter, and consequently would have diminished it but  $\frac{1}{8}$  of a Minute; which is a much less Quantity than the Ancients pretended to observe to.

But, supposing they could have observed even to Seconds, yet that could not have contradicted it; because 'tis possible the Sun may have approached as much nearer us as that Diminution amounts to; and for which he saith he could shew a Reason.

Sir *Isaac Newton* also, in his *Opticks*, gives good Reasons to suppose the Sun and fixed Stars to be great Earths vehemently hot; whose Heat is conserved by the greatness of their Bodies, and the mutual Action and Re-action between them and the Light which they emit; and whose Parts are kept from fuming away, not only by their *Fixity*, but also by the vast Weight and Density of the Atmospheres incumbent on them, and every way strongly compressing them, and condensing the Vapours and Exhalations which arise from them. The Light seems to be emitted from the Sun and fixed Stars (which probably are Suns to other Systems) much after the manner as Iron, when heated to such a Degree as to be just going into Fusion by the vibrating Motion of its Parts, emits with Force and Violence, copious Streams of liquid Fire all around. Great Bodies must preserve their Heat longest, and that, perhaps, in the Proportion of their Diameters.

Sir *Isaac Newton* hath made it probable, that the great Comet in the Year 1680, in its *Perihelion*, which would not entirely go off in 50000 Years. Whence we may guess, that if the Sun and fixed Stars be only Collections of dense and solid Matter, like the Planets, but heated to a very intense Degree, they may be many Millions of Years without losing any considerable Part of their Heat.

According to *Cassini*, the Sun's Distance from the Earth is 172,800,000 Miles *English*.

The Phænomena of the Sun's apparent Motion round the Earth, on which the Theory of this vast Body is established, are, by Astronomers, observed to be these:

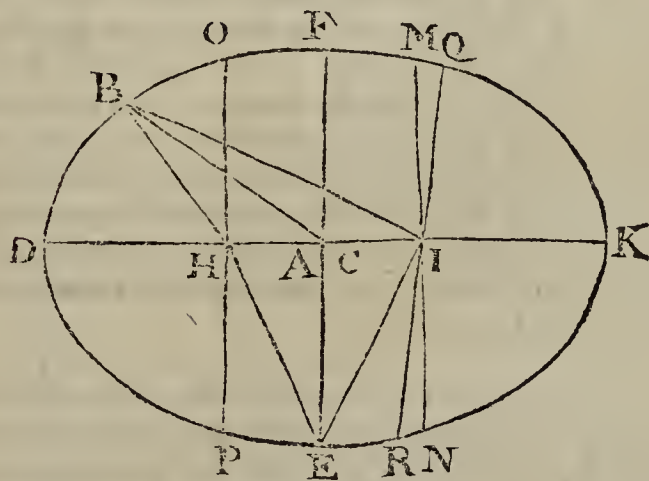
1. *That the Centre of the Sun's Body moves annually in the same Plane of the Ecliptick, and never deviates from the Line so called.*

Which apparent Motion of the Sun doth in reality belong to the Earth; which being at first put into such a Motion, and with such a Direction by the Great Creator, will always continue to move after the same manner; since here none of those *disturbing Forces* have any Place, which render the Motion of the Moon so irregular. Of which in its proper Place.

2. *But the apparent Motion of the Sun in the Ecliptick is very unequal; for a little after the Vernal, and a little before the Autumnal Equinox, he is in the Mean between the Extrems of his Motion; but his Motion is most swift a little after the Winter Solstice, as 'tis always most slow a little after the Summer one every Year.*

All which arises from the Earth's revolving not in a Circle, but an Ellipsis, in one of whose *Foci* or *Umbilici*, the Sun is placed. And with this Law also, that the Areas described by Lines drawn from the Earth to the Sun, shall always be equal, in equal and proportional Times.

In the Figure annexed, let the Sun be in the Point I, and let the Curve F D E K be an Ellipsis, or the annual Orbit of the Earth's Centre revolving round the Sun, and represented by B.



Let the Point H be the other *Focus*, and C the Centre of the Ellipsis; K D its great Axis, or the *Linea Apsidum*; and D the Aphelion, and K the Perihelion of the Earth. F E is the lesser Axis, I C, or C H is the *Eccentricity*, or the Distance between the Centre and the *Foci*. Let M N, or O P, be the *Latus Rectum* of the Ellipsis, and let the right Line A B bisect the Angle H B I: Now since by Lines drawn from its Centre to the Sun, the Earth describes always Areas proportional to the Times of its Motion in the Orbit, it will describe equal Areas in equal Times. But seeing the Line B I grows *longer* towards and at the Aphelion, and *shorter* at and about the Perihelion, the Earth must move slower in the former, and swifter in the latter Case. And indeed the Velocity of the Earth's Course in her Orbit, will always be in a reciprocal Ratio of her Distance from the



the Sun ; so that if the Distance between D and I be double to that between K and I, she will move twice as fast in the Perihelion as in the Aphelion.

3. And from this Figure 'twill be apparent, that the Sun's Diameter will appear *greater* when the Earth is in her Perihelion, which is a little after the Winter Solstice, and *less* when she is in her Aphelion, which is a little after the Summer Solstice, as is found by Observation. And this Difference in his apparent Diameter, shews also that the Earth moves not in a Circle, but an Ellipsis round the Sun.

4. Those Places in the Ecliptick, in which these greatest Differences of the apparent Motions and Diameters of the Sun happen, in process of time are *changeable*, and do move forward (or *in consequentia*) equally. For tho' the *Aphelia* and *Nodes* of the Planets are really at rest and immoveable; yet because of the annual Cession of the Equinoxes *in antecedentia*, they appear to be moved forward just the same Quantity.

5. If you suppose the Ecliptick to be bisected in the Equinoctial Points, the Sun appears to stay about eight Days longer in the *Northern* than in the *Southern* Half of that Circle.

For the Elliptick Orbit of the Earth will be cut unequally by a Line passing through the two Equinoctial Points: The Perihelion not being far from the Winter Solstitial Point, the Equinoctial Points will not be coincident with the longer Axis, but almost with the *Latus Rectum*; for in the Figure above the Line of the Equinoxes, Q R is not much different from N M the *Latus Rectum*.

But this Inequality of the Sun's apparent Motion, is not now the same as it was in *Ptolemy's* Time, and is continually changing, and in process of Time the Equinoctial Points will come to be in K and D; and then there will be no Difference in the time of the Sun's Stay in either Segment of the Ecliptick: But after this it will encrease again, and then again decrease as now, if the Earth's annual Motion be continued.

6. And yet the Spaces, or Times of the Earth's entire Revolution in her Orbit, are all equal one to another, and are what we call *Years*, containing each 365 Days, 5 Hours, and 49 Minutes nearly.

7. The Angle of the Inclination of the Planes of the Ecliptick and Equator, or the Sun's greatest Declination, hath been always invariably the same, *viz.* 23, 30.

8. The Sun's Diurnal Parallax is almost insensible, and his Menstrual Parallax is scarce 15 Minutes of a Degree.

And this is of the greatest use in Astronomy thoroughly to understand; nay, of such an absolute Necessity, that, without its Knowledge, neither the Distances nor Magnitudes of the Sun or Planets, can be obtained to any tolerable Certainty.

There have been three ways made use of by Astronomers, to find the Sun's Horizontal Parallax.

1. That of the famous *Hipparchus*, which proceeds on the Theorem which our Mr. *Horrox* hath accurately described and explained, and which is exactly and geometrically certain, and would do if the Parallax of the Sun were any considerable Quantity; but all that we can accurately conclude from it is, that it is not so; and consequently that the Distance of the Sun is vastly great. See Mr. *Whiston's Prælect. Astron.* p. 61. where there is a short Account of this Method.

2. The second way of finding the Sun's Horizontal Parallax, is that which 'tis said *Aristarchus Samius* first used, and hath been followed by *Kepler*, *Vendeline*, and more especially by *Ricciolus*. This supposes that you have the exact Moment of the Time of the *Half-Moon*, or the *Dichotomization*, or *Bisection* of her Disk, by the Light and Shadow; and some other things, as difficult to obtain as what you seek for: And therefore I shall say no more of it, than only to refer you to Mr. *Whiston's* Book, p. 66. where you have a good Account of this Method; because I must give you an account of

3. A third way of finding this Horizontal Parallax of the Sun; which though it be not so direct, is yet more accurate and exact than either of the former.

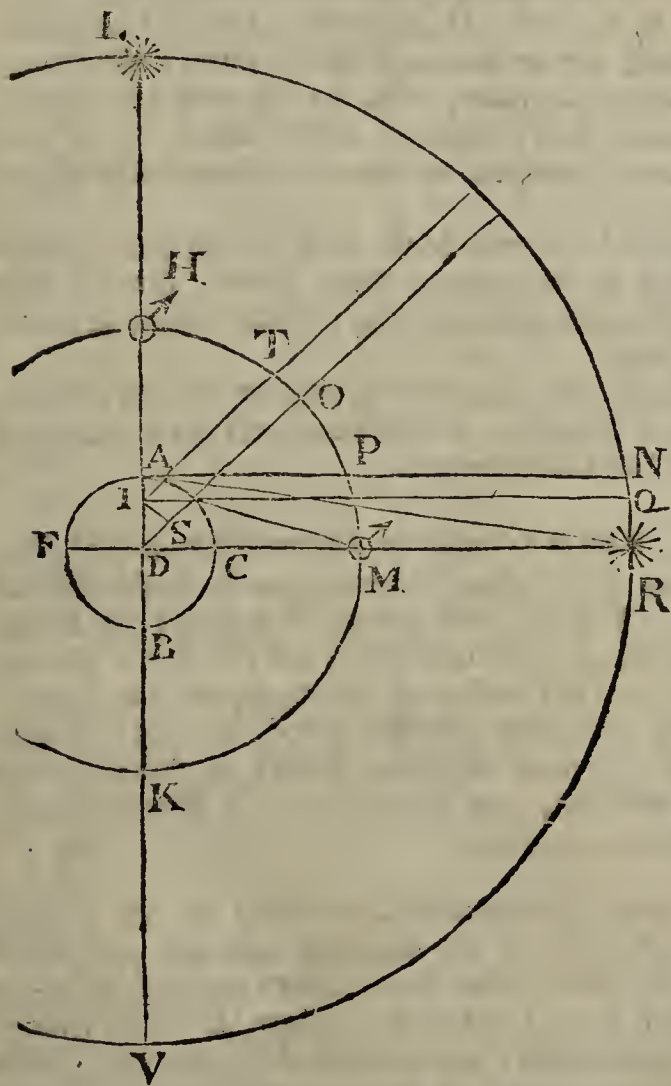
And this depends on a Method of determining first the Parallax of *Venus* or *Mars*.

The annual Parallax of the Fixed Stars, being by late Observation established, the *Copernican* System is so too, and the *Proportions* of the Distances of all the Planets from the Sun are given. And since 'tis clear in that System, that not only *Mars* and *Venus*, but even *Mercury*, do sometimes come nearer to the Earth than the Sun ever doth, and consequently must have all of them a greater Parallax than the Sun at such times; from hence it is manifest, that if we can get the Parallax of *Mars*, when in Opposition to the Sun, or that of *Venus* and *Mercury*, when in Conjunction with him, the Sun's Parallax will be discovered. Indeed, as to *Mercury*, he is usually so hid in the Sun, and his Motion is yet so indetermin'd, that nothing certain can be established about his Parallax. And the Conjunctions of *Venus* and the Sun are so rare (and that Time only is proper for it) that its Parallax is as yet not accurately enough determined.

There remains then *Mars* only, who being sometimes distant from the Earth but half as far as the Sun; and being at such times, when he is in Opposition to the Sun, very conspicuous and fit for Observation, is much the most fit Planet for our present Purpose. *Cassini* seems to have been the first that thought of, and practis'd this way; but our Mr. *Townley's* Invention of the *Micrometer* hath been very serviceable to him in it, as well as of the greatest Use in other Astronomical Observations. Before we describe the Method of *Cassini* for finding the Sun's Parallax, I must remind you, that the Parallax of *Mars*, for instance, is only the Difference between the apparent Place of that Planet, with respect to the Earth's Centre, and to a Point on its Surface, when the Planet is exactly in the Observer's Horizon; that is, you must suppose two Observers, one with his Eye at the Earth's Centre, and the other Eye at the Earth's Horizon, at the other Extremity of a Semi-



Semidiameter of the Earth, whose Position is normal to that Line which connects the Earth's Centre, and that of *Mars*, the latter being accurately in the Horizon of that Observer, who is supposed at the Surface. And thus, for Instance, the Moon's Parallax may be obtained by the Observations of two Astronomers at the same Minute of Time, if she be *Vertical* to one of them, and *Horizontal* to the other; because the Moon's Place to the Vertical Observer will be the same as if he had seen her from the Centre of the Earth. And this Method, with good Instruments, will do for any other Planet or Fixed Star. But the Method of *Cassini* for finding the Parallax of *Mars* (*v. gr.*) hath this great Advantage in it, that it may be performed by the Observation of but one Astronomer furnished with a good Telescope and Micrometer, since the Part of the other may be supplied by means of the Fixed Stars: Of which now take *Blanchinus's* Account in the *Leipsick Acts* of *October*, 1685, with some few Explications and Corollaries. Let the Circle *A F B C* represent the Earth's Equator *H K M*, the Diurnal Ark of *Mars*, when he moves in the Equator, *L V R*, as the Equinoctial in the Heavens, extended infinitely in the Region of the Fixed Stars. Let *Mars* be in *A*, in the Plane of the Equator; then his Diurnal Revolution will be truly represented by the Motion of the Line *D H* round *D* as a Centre, in the Plane of the Equinoctial, so as to form the Circle *H M K*,



which the Planet is supposed to describe in 24 Hours round the Earth, without any regard now to any other Motion. Then if you suppose this Circle to be divided into 24 equal Parts, through each of which a Plane shall pass at right Angles to the Equator, and also through the Centre *D*; these Planes will be the Planes of the Hour-Circles, and will also be *Meridians*, with respect to Places on the Earth. Let the right Line *L H A V*

be one of these Planes, or the Meridian of the Place *A* in the Earth's Equator, where an Observer sees the Planet *Mars*, and the Fixed Star *L* in one and the same right Line. Now if the Star and the Planet had only the same Diurnal Motion, they would be both together again at the same Place, or in the same right Line, at the end of 24 Hours; and if the Diurnal Motion be supposed equable, in six Hours the Planet and Star would be in the right Line *F D M R*, at right Angles with the Meridian *L H D*, or in the Astronomical Hour-Circle of six. Wherefore an Eye placed at the Earth's Centre, would always see the Planet and the Star in one and the same right Line, or in conjunction together, whether in the Meridian, or any other Hour-Circle. But it can't be so to an Eye at the Earth's Surface, as suppose at *A*; for though under his proper Meridian both the Fixed Star and the Planet will appear to him in the same right Line *A H L*, yet in any other Meridian, as suppose that of *D R* (which, in respect of the Place at *A*, may be considered as the Hour-Circle of six) *Mars* will appear to him in the Plane *A M*, but the Fixed Star in the Plane *A R*. To him therefore *Mars* will either appear *Retrograde*, or to move in *antecedentia*, or the Star to move in *consequentia*, altho' in reality both are supposed to have the same Diurnal Motion. And though he knows that they are both at the six Astronomical Hour-Circle, yet *Mars* will appear to be past it, before the six Hours are expired: Because the *sensible* sixth Hour, with regard to the Place *A*, is not the Plane *F D R*, but *A P N*. And the Difference of Time intervening between *Mars* coming to the *sensible* Hour-Circle of six, and the *rational* or *real* one, which may be called the Planet's *Horary Parallax*, is measured by the Ark of the Equator *P M*, which *Mars* by his Motion describes. And the Quantity of this Ark is equal to that of the Angle *P A M*, or its alternate *A M D*; that is, equal to the Angle of the Earth's Semidiameter, when seen in *Mars*; and this is that *Parallax* of *Mars* which we have been seeking. Wherefore if the Ark *P M* be just one Degree, *Mars* will appear to have passed the Plane *A P* four Minutes of an Hour before the six Hours would be expired in his passing by the Meridian.

The further *Mars* moves from the Earth, the lesser will be the Angle of its apparent Semidiameter in *Mars*, and consequently the lesser will be the above-mentioned Difference of Time between the Transit of the Planet by the *sensible* and *rational* Hour-Circle of six.

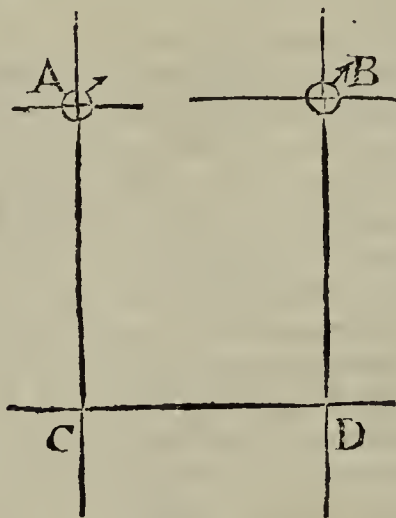
And if his Elongation from the Earth could come to be so great as that of the Fixed Stars, the Angle *A R D*, or its Equal *N A R* would then come to be so very small, as to be scarce sensible; so that when the Star is in the Plane *D R*, it would appear in that of *A N*.

And by this means a Fixed Star, or rather a good Pendulum Clock, made to move with the Star's Hour, will supply the Want of another Observer, in the Place represented by *C*; for all that an Astronomer there could do, is only to assure us, that he had seen *Mars* in the same Plane of his Meridian, or of our sixth Hour-Circle, when he appears to us in another Position. But this our Clock can inform us of, by shewing us that Time after *Mars* hath transited our Meridian. For since 'tis plain that the Star *L*, in six Hours after it hath passed our Meridian, will be in the Plane of the Hour-Circle



Circle D R, we shall know the Star is actually in that Plane, by our Clock's shewing us; that the Time is elapsed. And because, with regard to the Fixed Stars (whose Distance is so immense) the Plane of the *sensible* Hour-Circle of fix is coincident with that of the *real* one; if, when fix Hours are past from the Star's transiting our Meridian, a Plane be imagined to pass through our Eye, and the Star parallel to the Earth's Axis, that Plane must be that of the sensible Hour-Circle of fix, and in which the Star must necessarily be. But *Mars* will appear to differ from this; by so many Minutes of his Parallel, as are the Number of his Parallax. Counting therefore by the Pendulum the Seconds of Time which intervene between the Transit of *Mars*, and of the Fixed Star, and allowing four such Seconds for every Minute of a Degree, you will have the Quantity of the Angle M A N, or A M D, which is the Parallax of the Plane sought.

But how this Difference of Time is observed, I must next shew you. In the common Focus of the *Object* and *Eye-glasses* of the Telescope you observe with, there must be placed at least four fine Threads,



or Hairs, intersecting one another at right Angles; and the Telescope furnished with its *Micrometer*, must be so moved up and down, 'till that Fixed Star which is then nearest the Planet *Mars* shall appear to pass along one of the Hairs, as the Image of the Planet moves in the Telescope, as it must do, parallel to the Equator; for then the Hairs will, in that Position, be also parallel to the Equator; and the other Hairs which cross them at right Angles, will answer to the Circles of right Ascension; as in the Figure annexed, where the two parallel Threads A B and C D, have two others, A C and B D, placed at right Angles to them, just as the Equator and all its Parallels do intersect the *Meridians*, or Circles of right Ascension always at right Angles; the Observer then must wait a while with his Telescope and Micrometer adjusted, 'till the Planet and Fixed Star, being both carried together by the same apparent diurnal Motion, come to one and the same Meridian; and then the exact Time of the Appearance must be noted. After six Astronomical Hours, the Fixed Star will be come into the Plane of the sixth Hour-Circle, but *Mars* will be got thither a little before the Star. About the Hour of six therefore the Telescope must be used again, and the Hairs retaining their former Position, must be brought into the Plane of the Hour-Circle of fix, and there fixed. Then the exact Moment of Time must be noted when *Mars* appears by his diurnal Motion to move along by

the transverse Hair A C; and the exact Difference in Time also between the Planets and the Star's coming thither afterwards, must be nicely counted, as being the Time of the Horary Parallax of *Mars*: which being turned into Parts of a Degree, as above shewed, is the Horizontal Parallax of the Planet required.

By this Method, our *Flamsteed*, and *Cassini* at *Paris*, found the Parallax of *Mars* to be about 25 Seconds, and certainly not more, but probably a little less.

Having thus gain'd the Parallax of *Mars*, let us next endeavour to obtain by it the thing at first proposed, that is, the Sun's Horizontal Parallax; which will be easily had from that of the Planet *Mars*. For since at this time of Observation of the *Martial* Parallax, *i. e.* when *Mars* is in Opposition to the Sun, the Sun must be more than twice as far distant from the Earth as the Planet *Mars* is, the Sun's Parallax can't be quite half so much as that of *Mars*, and therefore may be accounted not to be above 10 or 12 Seconds at the most. And this agrees with the Observations of *Vendeline*, and those made by *Cassini* about the Parallax of *Venus* also.

Supposing then the Sun's Horizontal Parallax to be about 10 Seconds, his *Distance from the Earth* will be thus found: As the right Sine of ten Seconds is to Radius, so is the Earth's Semidiameter in *English* Statute Miles, to the Sun's Distance in the same Miles; and this way the Sun's Distance is found to be about 81,000,000 of our Miles.

The Sun's true Diameter may also by this means be had; for as Radius is to the Sine of the Sun's apparent Diameter, *viz.* 31 Minutes and a half; so is the Sun's Distance above found to his real or true Diameter, or about 800,000 Miles *English*.

Indeed the true Magnitude of the Sun's Body cannot be determined from hence, because that depends also on his Density, which cannot be found this way.

From this usual way of finding the Sun's Horizontal Parallax, the Astronomers draw these and such like Consequences:

1. That it is easier to determine the annual Parallax of the Fixed Stars, than the Sun's diurnal one. For since the annual Parallax of the Fixed Stars is at least Quadruple of the Sun's diurnal one, as the Parallax of *Mars*, by whose Knowledge the Solar one was found, is almost double of it; it must be better subject to Astronomical Observation, and be capable of a Determination twice as accurate.

2. In Astronomical Calculations by the Tables, this Parallax of the Sun may generally and safely be neglected. For since it doth not arise to above a sixth Part of a Minute of Time, it will be scarcely considerable; our present Astronomical Tables not being capable of bringing us to a greater Accuracy and Exactness.

3. The Earth's Distance from the Sun being given, the Distances of the other Planets, both from the Sun and the Earth, are also given; and in the following Table you have their Distances from the Sun, their Diameters, and the Times of their Periodical Revolution.



|                |   |             |
|----------------|---|-------------|
| <i>Mercury</i> | is distant from the<br>Sun, of <i>English</i> Miles | 32,000,000  |
| <i>Venus</i>   |   | 59,000,000  |
| The Earth      |   | 81,000,000  |
| <i>Mars</i>    |   | 123,000,000 |
| <i>Jupiter</i> |   | 424,000,000 |
| <i>Saturn</i>  |   | 777,000,000 |

|   |                |        |
|---|----------------|--------|
| The Diameter in <i>Eng-<br/>lish</i> Miles of | <i>Mercury</i> | 4240   |
|   | <i>Venus</i>   | 7906   |
|   | Earth          | 7935   |
|   | <i>Mars</i>    | 4444   |
|   | <i>Jupiter</i> | 81155  |
|   | <i>Saturn</i>  | 67870  |
|   | Sun            | 763460 |

|   |                |    |       |    |
|---|----------------|----|-------|----|
| The Time of<br>the Periodick<br>Revolution of | <i>Mercury</i> | is | 87    | 23 |
|   | <i>Venus</i>   |    | 224   | 17 |
|   | Earth          |    | 365   | 6  |
|   | <i>Mars</i>    |    | 686   | 23 |
|   | <i>Jupiter</i> |    | 4332  | 12 |
|   | <i>Saturn</i>  |    | 10759 | 7  |

**SUNDAY Letter**, the same with *Dominical Letter*.

**SUPERBUS Musculus**. See *Attollens Oculorum*.

**SUPERCILIUM**. See *Cilium*.

**SUPERCILIUM**, in *antient Architecture*, is the uppermost Member of a Cornice, which the Moderns call by the Name of the *Corona*, *Crown*, or *Larmier*. It is also used for the square Member under the upper Tore in some Pedestals, and it is by some confounded with the Tore itself.

**SUPERFICIAL Content**. See *Area*.

**SUPERFICIAL Fourneau**, a Term in Fortification, the same with *Caïsson*, which is a wooden Chest, or Box, with 3, 4, 5 or 6 Bombs in it, and sometimes 'tis filled only with Powder, and is used in a close Siege, by being buried under Ground with a Train to it, to blow up any Lodgment that the Enemy shall advance to. Therefore they usually express it thus: "After the *Mine* " or *Forneau*, had destroyed the *Bonette*, a *Caïsson* " was buried under the Ground, thrown up, and " the Enemy advancing to make a Lodgment on " the Ruins of the *Bonette*, the *Caïsson* was fired, " and blew up the Post a second time.

**SUPERFICIAL Numbers**; the same with *Plain Numbers*.

**SUPERFICIES**, the same with *Surface* (which see) is Length and Breadth only, without Thickness.

**A Rectilinear SUPERFICIES**, is one which is comprehended between right Lines.

**A Curvilinear SUPERFICIES**, is one that is comprehended between Curve Lines.

**A Plane SUPERFICIES**, is such as has no Inequalities; but lies evenly between its boundary Lines.

**A Convex SUPERFICIES**, is the exterior Part of a spherical Body.

**A Concave SUPERFICIES**, is the internal Part of an orbicular Body.

**SUPERFICIES**; they are frequently placed upon a Sector, two Lines (one on each Leg) which Mr. Gunter calls very properly *Lines of Superficies*. They are made by finding mean Proportionals between the two Homologous Sides, and the hundredth Part of such a Side, or by a Table of Square Roots; which Roots may be taken out of

the Divisions of the Lines of Lines, and they will give the proper Distances from the Centre, where the 10 (or 100) unequal Divisions must be placed.

### The Use of the Line of Superficies.

1. To find the Proportion between two or more Similar Superficies.

Take one of the Sides of the greater Surface, and put it over from 10 to 100, at the End of the Line of Superficies. Then take the corresponding Sides of the Similar Surfaces severally, and carrying the Points of the Compasses so that they fall on the same Number on each Leg, they will there shew the Proportion which they bear to an hundred.

2. To augment a Surface, or to diminish it in a given Ratio, as suppose in the Ratio of 2 to 5.

Take the Side of the Surface, and to it open the Sector in the Points 2 and 2, in the Line of Surfaces; and, letting the Sector lie, the Distance between 5 and 5 will give you the Side of a Similar Figure, whose Area shall exceed that of the given one in the Proportion required. And proceed *vice versa*, for diminishing.

3. To add together, or to subtract one from another Similar Surfaces.

Find first the Ratio between the Surfaces by *Prop. 1.* and then add or subtract the Numbers, expressing those Proportions by *Prob. 2.* and then augment or diminish by the precedent Problem.

4. To find the Ratio between the unlike, or non-Similar Surfaces.

First find *Squares* equal to those Surfaces, and then those being Similar Figures, you may easily find the Ratio they bear by *Prob. 1.*

**SUPERFŒTATION**, is when after one Conception another succeeds, so that both are in the Womb together: *Sennertus* makes mention of frequent Cases of this Nature.

**SUPER-INSTITUTION**, one *Institution* upon another; as where *A.* is admitted and instituted to a Benefice upon one Title, and *B.* is admitted, instituted, &c. by the Presentment of another.

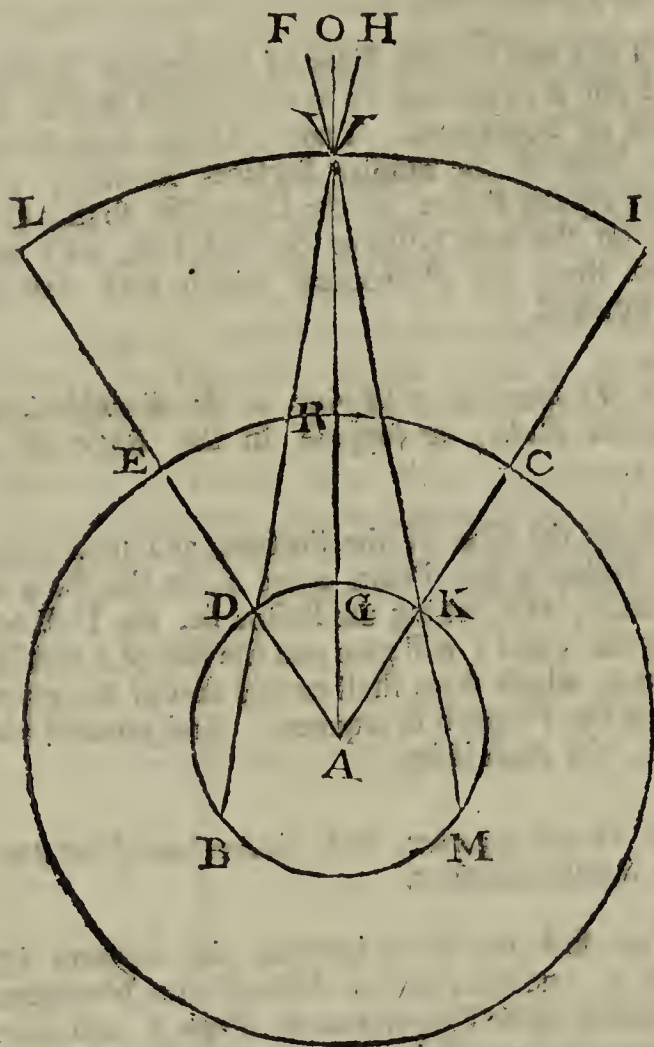
**SUPERIOR Planets**, are *Mars*, *Jupiter* and *Saturn*: They are so called, because they move in Orbits round the Sun, which are larger than that of our Earth, and so are above us with regard to the Sun, and never can come between the Earth and him. The Theory of the Motions of these Superior Planets, to an Eye placed on the Earth, are these:

1. That, besides their apparent Motion from *East* to *West*, which the diurnal Rotation of the Earth occasions, they appear usually to move also slowly from *West* to *East*, and to make entire Revolutions this way; as in reality they do in their Orbits round the Sun: But *Mars* moves faster than



than *Jupiter*, and *Jupiter* than *Saturn*, in proportion to their several Distances from the Sun.

But sometimes they will also to an Eye at our Earth, appear to move the contrary Way from *East* to *West*, which was a great Difficulty in the old Astronomy, but may easily be solved by the Consideration of the following Diagram; in which



let A be the Sun, M G B the Orbit of the Earth, in which it moves annually from M by G, towards B, from *West* to *East*. Let the Circle Q R S be the Orbit of any Superior Planet moving the same way as the Earth. Let the Circle T V X represent the Sphere of the Fixed Stars supposed at an immense Distance, and with respect to which, the Retrogradation and Stations, &c. of the Planet are accounted. For though to an Eye placed in the Sun at A, the Planets would appear to move always uniformly and equally forward in their Orbs, as in reality they do, yet to an Eye placed on the Surface of our Earth, the Phænomena will be very different, and the Planets will appear sometimes to be *Retrograde* and *Stationary* in their Motions, as well as other times *Direct*. For, suppose the Earth at M, and *Jupiter* in C, while *Jupiter* moves from C to R, and describes the Ark C R, a Part of its Orbit round the Sun in A: The Earth, because its Angular Motion is much more swift, will describe the Ark M G; so also while *Jupiter* describes the Ark R E, the Earth will move from G to B. Now while the Earth is describing the Ark M K, *Jupiter* will appear to be moving a little forward; but whilst the Earth moves through the Ark K G, *Jupiter*, though in reality still *Progressive* or *Direct*, will appear to be *Retrograde*, and to move backward from F to O: Nor can it be otherwise, while the Earth moves from G to D, and while *Jupiter* describes the Ark R E,

But when the Earth comes towards B, then the Planet will appear a little *direct* again, and his apparent *Progressive* Motion will for a while continually encrease. And when the Earth is near K or D, the Planet will appear to be *Stationary* in F or H. So that 'tis obvious to see that the apparent Motion of the Planets will be very irregular and unequal, sometimes swifter, and sometimes slower, according to their Position with respect to the Earth.

3. The *Progressive* Motion of every Superior Planet will be swiftest in his Conjunction with the Sun, as his *Retrograde* Motion will be swiftest in his Opposition. For the apparent direct Motion of the Planet in his Conjunction, arises from the Sum of the Motions of the Earth and Planet then moving directly contrary one to another; and the *Retrograde* Motion in the Opposition arises from the greatest *Excess* of all the Terrestrial Motions above the Planetary, both from there being then the least Distance between the Earth and the Planet, and from the Parallelism of their Motions at that time; as is clear from the Consideration of the Figure.

**SUPERONERATIONE Pasturæ**, is a *Writ Judicial*, that lies against him who is impleaded in the County, for the over-burdening of a Common with his Cattle, in case where he was formerly impleaded for it in the County, and the Cause is removed into the King's Court at *Westminster*.

**SUPERPARTICULAR Proportion**, is when one Number or Quantity contains another once, and one such Part, whose Numerator is one; then the Number so contained in the Greater, is said to be to it in *Superparticular Proportion*.

**SUPERPARTIENT Proportion**, is when one Number or Quantity contains another once, and some Number of *Aliquot Parts* remaining; as  $1\frac{1}{2}$ ,  $1\frac{1}{3}$ ,  $1\frac{2}{3}$ , &c.

**SUPER Prærogativa Regis**, is a *Writ* which lay against the King's Widow, for marrying without his Licence.

**SUPER Statuto**, is a *Writ* that lay against the King's Tenant holding in Chief, which alienateth the King's Land without his Licence.

**SUPER Statuto de Articulo Cleri**, is a *Writ* against the Sheriff, or other Officer, that distrains in the King's High-way, or in the Glebe-Lands, anciently given to Rectories.

**SUPER Statuto facto pour Seneschal & Marshal de Roy**, &c. is a *Writ* lying against the Steward or Marshal, for holding Plea in the Court of *Freehold*, or for *Trespass*, or Contract not made within the King's Household.

**SUPERLATIVE Degree**, in Grammar, is when an *Adjective* hath joined to its natural and ordinary Signification, the Word *most* or *very*, as *most-Wise*, *very Good*.

**SUPERPURGATION**. See *Hypercatharsis*.

**SUPERSCAPULARIS Superior**. See *Supra Spinatus*.

**SUPERSEDEAS**, is a *Writ* in diverse Cases, and signifies in general, a Command to stay, or forbear the doing of that which ought not to be done, or in appearance of Law were to be done, were it not for that whereon the *Writ* is granted.

Thus: A Man regularly is to have Surety of Peace against him of whom he will swear he is afraid; and the Justice required hereunto cannot deny



deny it him: Yet if the Party be formerly bound to the Peace, either in *Chancery*, or elsewhere, this Writ lies to stay the Justice from doing that which otherwise he ought not to deny.

**SUPER Statutum** *Edw. 3. versus Servants & Labourers*, is a Writ lying against him who keeps my *Servants*, departed out of my Service, against Law.

**SUPER Statuto de York**, *quo nul fera Viteller, &c.* is a Writ that lies against him that uses Victualling either in Gros, or by Retail in a City, or Borough-Town, during the Time he is Mayor, &c.

**SUPERVISOR**, signifies a Surveyor, or Overseer: It was formerly, and is still among some a Custom, especially of the better sort, to make a *Supervisor* of a Will; but it is to little purpose: However the first might be good, that he should *Supervise* the Executor, and see the Will truly performed.

**SUPINATION**, in *Anatomy*, the Action of a *Supinator* Muscle; or that Motion, whereby it turns the Hands so, as that the Palm is lifted up towards Heaven.

**SUPINATOR Radii Brevis**, is a Muscle of the *Radius*, which ariseth partly Tendinous and Flethy from the superior and external Part of the *Ulna*, next the *Radius*, and passing obliquely transverse over that Bone, is so inserted to its superior Part below the Prominence of the *Radius*, where the round Tendon of the *Biceps* endeth: It helps with the *Supinator Longus*, to move the *Radius* outwards.

**SUPINATOR Radii Longus**, is a Muscle of the *Radius*, which ariseth broad and fleshy from the superior and external Part of the *Os Humeri*, three Fingers breadth below the Termination of the *Deltoides*, and descending obliquely inwards, it gradually lessens it self, and becomes a flat, broad Tendon, which likewise grows narrower till it is inserted to the external and inferior Part of the *Radius* near the *Carpus*, helps with *Supinator Brevis*, to move the *Radius* outwards.

**SUPPEDANEA**. See *Supplantalia*.

**SUPLANTALIA**, are Plaisters applied to the Feet; these for the most part are made of Leaven, Mustard, wild Radish, Salt, Soap, Gunpowder, Euphorbium, &c. They are called also *Suppedanea*.

**SUPPLEMENT** of an Ark, in *Geometry* or *Trigonometry*, is the Number of Degrees that it wants of being an entire Semi-circle; as Complement signifies what an Ark wants of being a Quadrant.

**SUPPLICAVIT**, is a Writ issuing out of the *Chancery*, for taking the Surety of Peace against a Man: It is directed to the Justices of Peace of the County, and the Sheriff, and is grounded upon the Statute, *Anno 1 E. 3. Cap. 16.* which ordains, That certain Persons in *Chancery* shall be assigned to take care of the Peace. This Writ was formerly called *Breve de minis*.

**SUPPORTED**, in *Heraldry*, a Term used of the uppermost Quarters of a Shield, when it is divided into several Quarters; these seeming, as it were, to be supported and sustained by those below.



**SUPPORTERS**, of *Coat Armour*, are those Animals that Noblemen carry to support their Shields: As Quadrupedes, Birds, or Reptiles; as Lions, Leopards, Dogs, Unicorns, Eagles, Griffons, Dragons. To Persons under the Degree of Bannerets, it is not permitted to bear their Arms supported.

**SUPPOSITION**, in *Musick*, is the using of two successive Notes of the Value, as to Time; the one of which being a Discord, supposes the other a Concord.

**SUPPOSITORY**, is an oblong piece of a kind of Paste, of about a Finger's length, which in some Cases is put up into the Fundament, to purge the Patient; 'tis usually compounded of Honey, Salt, purging Powders, &c. *Blanchard*.

**SUPPRESSION**, in *Physick*, a Term used of the Humours that are retained in the Body by means of some Obstruction or Stoppage of the usual Outlets, as a Suppression of the *Menses*, the *Urine*, &c.

**SUPPURATION**. See *Abscessus*.

**SUPPURATIVE**, in *Physick*, a Medicine that promotes Suppuration.

**SUPRA Spinatus**, or *Supra Scapularis*, is a Muscle so called, because it is placed above the Spine of the Shoulder-blade: It ariseth fleshy from the superior part of the *Basis Scapulae*, that is above its Spine; as also from the said Spine and *Costa superior* of the *Scapula*; from thence passing between the *Processus Coracoides*, and *Anchoræformis*, it grows less, and becoming Tendinous, marches over the Articulations of the *Humerus*, joining its Tendons with the *Infra-spinatus*, is inserted to the Head of the *Os Humeri*. The proper Use of this Muscle, is to lift the Arm upwards towards the *Occiput*.

**SURA**, the same with *Os Fibulae*.



**SUR ANCRE** in *Heraldry*, as a Cross, *sur ancrée*, i. e. double anchor'd, is a Cross with double Anchor-Flukes at each End, as in the Escutcheon.

**SURALIS**, is Branch of the *Vena Cruralis*; it divides into two Branches, the one External, and the other Internal, which is the biggest; and each of those Branches divide again into two more: This Vein distributes its Branches upon the Fat of the Leg, and makes with the Branches of the *Poplitea*, all those *Plexus* of Veins which are conspicuous on the upper Part of the Foot.

**SURAL Vein**, is a Vein which runs down on the Calf of the Leg.

**SUR cui in Vita**, is a Writ that lies for the Heir of that Woman, whose Husband has alienated her Land in Fee, and she brings not the Writ *Cui in Vita*, for the Recovery of her own Land; In this Case her Heir may have this Writ against the Tenant after her Decease.

**SURD Roots, or Numbers.**

When any Number or Quantity, hath its Root proposed to be Extracted, and yet is not a *trile Figurate Number* of that kind: That is, if its Square Root being demanded, it is not a *true Square*: If its Cube Root being required, it self be not a *true Cube*,



Cube, &c. Then 'tis impossible to assign, either in whole Numbers or Fractions, any exact Root of such Number proposed. And whenever this happens, 'tis usual in Mathematicks to mark the required Root of such Numbers or Quantities, by prefixing before it the proper Mark of Radicality, which is  $\sqrt{\phantom{x}}$ : Thus  $\sqrt{\phantom{x}}: 2$  signifies the Square Root of 2, and  $\sqrt[3]{\phantom{x}}: 16$  or  $\sqrt{\phantom{x}}: (3) 16$ , signifies the Cubick Root of 16: Which Roots, because they are impossible to be expressed in Numbers exactly (for no effable Number, either Integer or Fraction multiplied into it self can ever produce 2; or being multiplied Cubically, can ever produce (16) are very properly call'd *Surd Roots*.

There is also another way of *Notation* now much in Use, whereby Roots are expressed, without the Radical Sign, by their *Indexes*. Thus, as  $x^2$ ,  $x^3$ ,  $x^5$ , &c. signifie the Square, Cube, and 5th Power of  $x$ ; so  $x^{\frac{1}{2}}$ ,  $x^{\frac{1}{3}}$ ,  $x^{\frac{1}{5}}$ , &c. signifie the Square Root, Cube Root, &c. of  $x$ . The Reason of which is plain enough, for since  $\sqrt{\phantom{x}}: x$  is a Geometrical mean Proportional between 1. and  $x$ . So  $\frac{1}{2}$  is an Arithmetical mean Proportional between 0 and 1. and therefore as 2 is the Index of the Square of  $x$ ,  $\frac{1}{2}$  will be the proper Index of its Square Root, &c.

Observe also, that for Convenience or Brevity-sake, Quantities or Numbers, which are not *Surds*, are often expressed in the Form of *Surd Roots*,

Thus  $\sqrt{\phantom{x}}: 4 \sqrt{\phantom{x}}: \frac{9}{3} \sqrt{\phantom{x}}: 27$ , &c. signifie,  $2, \frac{3}{2}, 3$ , &c.

But altho' these *Surd Roots* (when truly such) are inexpressible in Numbers, they are yet capable of Arithmetical Operations (such as Addition, Subtraction, Multiplication, Division, &c. which how readily to perform, the Algebraist ought not to be ignorant.

*Surds* are either *Simple*, which are expressed by one single Term; or else *Compound*, which are formed by the Addition or Subtraction of simple *Surds*: As  $\sqrt{\phantom{x}}: 5 + \sqrt{\phantom{x}}: 2$ ;  $\sqrt{\phantom{x}}: 5 - \sqrt{\phantom{x}}: 2$ . or  $\sqrt[3]{\phantom{x}}: 7 + \sqrt{\phantom{x}}: 2$ : Which last is called, an *Universal Root*: And signifies the Cubick Root of that Number, which is the Result of adding 7 to the Square Root of 2.

*The Arithmetick of Surds consists of these principal Parts.*

#### I. To reduce Rational Quantities to the Form of any Surd Roots assigned:

Which is perform'd by Involving the Rational Quantity according to the Index of the Power of the *Surd*, and then prefixing before it the Radical Sign of the *Surd* proposed.

Thus to reduce  $a=10$  to the Form of  $\sqrt{\phantom{x}}: 15$ .  $\sqrt{\phantom{x}}: b$ , you must square  $a=10$ ; and prefixing the Sign, it will stand thus,  $\sqrt{\phantom{x}}: aa=\sqrt{\phantom{x}}: 100$ , which is in the Form of the *Surd* desired. So also if 3. were to be brought to the Form of  $\sqrt[4]{\phantom{x}}: 12$ , you must raise 3 up to its fourth Power, and then prefixing the Note of Radicality to it, it will be  $\sqrt[4]{\phantom{x}}: 81$ . or  $81^{\frac{1}{4}}$ , which is in the same Form with  $\sqrt[4]{\phantom{x}}: 12$ .

And this way may a simple *Surd Fraction*, whose Radical Sign refers only to one of its Terms, be changed into another, which shall respect both Numerator and Denominator. Thus,  $\frac{\sqrt{\phantom{x}}: 2}{5}$  is re-

duced to  $\sqrt{\phantom{x}}: \frac{2}{25}$  and  $\frac{5}{\sqrt{\phantom{x}}: 4}$ , to  $\sqrt{\phantom{x}}: \frac{125}{4}$ : Where the Radical Sign affects both Numerator and Denominator alike.

#### II. To reduce simple Surds, having different Radical Signs, (which are called *Heterogeneous Surds*) to others that may have one common Radical Sign, or which are *Homogeneous*.

Divide the Indexes of the Powers of the *Surds* by their greatest common Divisor, and set the Quotients under the Dividends; then multiply those Indexes cross-ways by each others Quotients, and before the Products, set the common Radical Sign  $\sqrt{\phantom{x}}$ : with its proper Index: Then involve the Powers of the given Roots alternately, according to the Index of each others Quotient, and before those Products, prefix the common Radical Sign before found.

To Reduce  $\sqrt[2]{\phantom{x}}: aa$  and  $\sqrt[4]{\phantom{x}}: bb$   
2) :  $\sqrt{\phantom{x}}: aa$  2)  $\sqrt[4]{\phantom{x}}: bb$

1 X 2  
 $\sqrt[4]{\phantom{x}}: bb$   $\sqrt[4]{\phantom{x}}: aaaa$

To reduce  $\sqrt{\phantom{x}}: 5$  and  $\sqrt[4]{\phantom{x}}: 7$   
 $\sqrt[2]{\phantom{x}}: 5$   $\sqrt[4]{\phantom{x}}: 7$

1 X 2  
 $\sqrt[4]{\phantom{x}}: 25$   $\sqrt[4]{\phantom{x}}: 2401$

#### III. To reduce Surds to the lowest Terms possible.

Divide the *Surd* by the greatest Square, Cube, Biquadrate, &c. or any other higher Power, which you can discover is contained in it, and will measure it without any Remainder; and then prefix the Root of that Power before the Quotient, or *Surd* so divided, and this will produce a new *Surd* of the same Value with the former, but in more simple Terms. Thus,  $\sqrt{\phantom{x}}: 16 a a b$ , by dividing by  $16 a a$  and prefixing the Root 4  $a$ , will be reduced to this  $4 a \sqrt{\phantom{x}}: b$  and  $\sqrt{\phantom{x}}: 12$ , will be depressed to  $2 \sqrt{\phantom{x}}: 3$ . Also  $\sqrt[3]{\phantom{x}}: c b^3 r$ , will be brought down to  $b \sqrt[3]{\phantom{x}}: cr$ . And this Reduction is of great Use whenever it can be performed: but if no such Square, Cube, Biquadrate, &c. can be found for a Divisor, then you must find out all the Divisors of the Power of the *Surd* propos'd; and then see whether any of them be a Square, Cube, &c. or such a Power as the Radical Sign denotes; and if any such can be found, let that be used in the same manner as is above said, to free the *Surd* Quantity in part from the Radical Sign. Thus, if  $\sqrt{\phantom{x}}: 288$  be propos'd; among its Divisors will be found the Squares 4. 9. 16. 36. and 144. by which if 288 be divided, there will arise the Quotients 72. 32. 18. 8. and 2. wherefore instead of  $\sqrt{\phantom{x}}: 288$ , you may put  $2 \sqrt{\phantom{x}}: 72$ , or  $3 \sqrt{\phantom{x}}: 32$ , or  $4 \sqrt{\phantom{x}}: 18$ . or  $6 \sqrt{\phantom{x}}: 8$



$6\sqrt{\phantom{x}} : 8.$  or laltly  $12\sqrt{\phantom{x}} : 2.$  and the same may be done in Species.

IV. *To find whether two Surd Roots given, are Commensurable or not.*

Those are called *Commensurable Surds*, which are to one another as Number to Number, as one Rational Quantity to another; or which are, when reduced to their least Terms, true Figurate Quantities of their own kind.

To discover therefore, whether they are such or not: If the Surds are of different kinds (or *Heterogeneous Surds*, as some call them) they must first be reduced to one kind, and then divided severally by their greatest common Measure; for if then there will come out Rational Quotients, the first Surds are *Commensurable*; but if the Quotients are Irrational, or Surd Numbers, or Quantities, then the proposed Surds are *Incommensurable*.

*V. gr.* To Examine whether  $\sqrt{12}$  and  $\sqrt{3}$  are Commensurable Surds, they being Homogeneous, I divide them severally by their greatest Common Divisor, which is  $\sqrt{3}$ ; and the Quotients are  $\sqrt{4}$  and  $\sqrt{1}$  that is 2 and 1. Wherefore, since 2 and 1. are Rational Numbers, I say that  $\sqrt{12}$  and  $\sqrt{3}$  are Commensurable Surds; or are to one another as 2 to 1. which is very plain; for no doubt  $12, 3 ::$  as  $4, 1.$  and 'tis plain that as Squares are to one another; so are their Roots; wherefore  $12, 3.$  as  $\sqrt{12} \sqrt{3}$  that is, as  $\sqrt{4} \sqrt{1}$  or as 2 to 1.

Whenever two Surds are divided by one common Divisor (tho' not the greatest, if their Quotients come out Rational; or are to one another as Number to Number, those Surds are certainly Commensurable.

If Fractional Surds were given, not having a common Denominator, they must first be reduced to their smallest common Denominator, and then if their Numerators are Commensurable, you may conclude the first Surd Fractions were so.

But if either the Numerators or Denominators of two Surds, proper Fractions, or mixt Numbers in the Form of Fractions (neglecting the Radical Sign) be Powers of that kind which the Radical Sign expresses, then they will need no Reduction: For if their Numerators or Denominators are Commensurable, the whole Surd Fractions proposed are certainly so. Thus, if it were enquired whether

$\sqrt{\frac{50}{25}}$  and  $\sqrt{\frac{72}{25}}$  are Commensurable Surds;

because 16 and 25 are Squares, or such Powers as the Radical Sign expresses or denotes, omitting the Sign  $\sqrt{\phantom{x}}$ : you need only compare the Numerators  $\sqrt{50}$  and  $\sqrt{72}$ ; which being divided by their greatest common Divisor,  $\sqrt{2}$ , the Quotients will be 5 and 6 (*i. e.*  $\sqrt{25}$  and  $\sqrt{36}$ ) Wherefore the given Surds are Commensurable, and are

to one another, as  $\frac{5}{4}$  to  $\frac{6}{5}$ ; and consequently, by

the precedent Rule may be expressed thus,  $\frac{5}{4}\sqrt{\phantom{x}}$ :

2 and  $\frac{6}{5}\sqrt{\phantom{x}} : 2.$

For an Instance in *Species*; suppose that it were enquired whether  $\sqrt{27aa}$  and  $\sqrt{12aa}$  were

Commensurable Surds; Divide each by the greatest common Divisor  $\sqrt{3aa}$ : And the Quotients  $\sqrt{9}$  and  $\sqrt{4}$  that is, 3 and 2. are Rational Numbers; and consequently, the proposed Surds are Commensurable.

#### *Multiplication of simple Surd Roots.*

If the Surds proposed be of the same kind, multiply them one by another, and prefix the common Radical Sign to the Product; but if the Surds are Heterogeneous, or of different kinds, they must be reduced first (according to Rule 2.) to Surds, having the same radical Sign.

Thus to multiply  $\sqrt{7}$  by  $\sqrt{8}$  the Product will be  $\sqrt{56}$ .

For since in all Multiplication, as 1. is to one Factor, so is the other to the Product; therefore here  $\sqrt{1} \sqrt{7} :: \sqrt{8} \sqrt{56}$ . But if 4 Terms are Proportionable, their Squares will be so too; wherefore  $1. 7. :: 8. 56.$  that is, 56 is the true Square of  $\sqrt{56}$ . and  $\sqrt{56}$  the true Root of  $7 \times 8 = 56$ .

#### *Other Examples.*

I. If  $\sqrt{8}$  were to be multiplied into  $\sqrt[3]{4}$  because they are not Homogeneous Surds, they must be reduced to such by Rule 2. and then they will stand thus,  $\sqrt[6]{512} \sqrt[6]{16}$ , which being multiplied into each other, and the common Radical Sign prefixed, will make  $\sqrt[6]{8193}$ ; and thus the  $\sqrt[6]{27}$  multiplied by  $\sqrt{9}$  when reduced, and rightly multiplied, produces  $\sqrt[6]{531441}$ .

II. When a Surd is to be multiplied by a Rational Quantity, that Rational Quantity ought first to be reduced to a Surd of like Nature with the true Surd. But 'tis oftentimes convenient only to connect them together, by prefixing the Rational Quantity to the Left-hand of the Surd. As suppose  $\sqrt{27}$  were to be multiplied by 6, the Product may commodiously be expressed thus,  $6\sqrt{27}$ ; and so if  $\sqrt[4]{9}$  were to be multiplied by 10, it will stand thus,  $10\sqrt[4]{9}$ .

III. And when two Rational Quantities are thus prefixed to two Surds of the same kind, you may find the Product of them, by multiplying the Rational Part by the Rational, and the Surd Part by the Surd; then those joined together, will be the Product required. Thus,  $6\sqrt[3]{7}$  multiplied by  $5\sqrt[3]{3}$  produces  $30\sqrt[3]{21}$ .

IV. If any Surd Root be to be multiplied into itself, or *Involved*, according to the Index of its proper Power, you not only cast away the Radical Sign, and then the Quantity, or Number remaining, is always the Square, Cube, or other Power required; and will always be Rational.

Thus the Square of  $\sqrt{11}$ , is 11.

The Cube of  $\sqrt[3]{30}$ , is 30.

Also  $2\sqrt{3}$  multiplied by  $8\sqrt{3} = 48.$  and  $3\sqrt{5}$  multiplied by  $2\sqrt{5} = 30.$

V. And if the Index of the Power be any even compound Number greater than two, and 'tis required to square such a Surd: There need only a Radical Sign, whose Index is half the former, be prefixed



prefixed to the Quantity, instead of the former Compound one, and it is done.

*V. gr.* Suppose you would *Square* this Surd,  $\sqrt[4]{12}$ ; because the Index 4 is compounded of 2 and 2;  $\sqrt{12}$  is the true Product, or the true Square of the *Surd Root*  $\sqrt[4]{12}$ . so also the *Square* of  $\sqrt[6]{10}$ , is  $\sqrt[3]{10}$ .

The Reason of which, is plain: For suppose the  $\sqrt[4]{16} = 2$  were to be squared; its *Square in Surds* will be expressed thus,  $\sqrt{16} = 4$ .

But when a simple Surd Quantity, whose Radical Sign hath for its Index some Ternary Number greater than 3, as 6, 9, &c. And 'tis required to Involve this Surd cubically. Then only prefix before the Quantity a Radical Sign, with an Index, which is one third of the former, and 'tis done. Thus, if  $\sqrt[6]{64}$ , were to be Cubed, it will be  $\sqrt[2]{64}$ , and the Cube of  $\sqrt[3]{512}$ , is  $\sqrt[3]{512}$ , &c. also the Biquadrate of  $\sqrt{5}$  is 25 (as being the Square of the Square of  $\sqrt{5}$ .) and the Cube of  $\sqrt[6]{81}$ , will be  $\sqrt{81}$  or 9.

In the general, to *Square*, *Cube*, &c. any *Surd Root*, is only to Square or Cube the Power, retaining the same Note of Radicality; but 'tis better where it can be done, to take one half,  $\frac{1}{3}$  Part, &c. of the Exponent of the Root, as is above shewn in the last particular Rules.

On the contrary, if you would extract the *Square*, *Cube*, or other Root of any Surd, you must double or triple, &c. the Exponent of the Radicality. Thus the *Square Root* of  $\sqrt{16}$  is  $\sqrt[4]{16}$ . the *Square Root* of  $\sqrt[3]{27}$  is  $\sqrt[6]{27}$ , &c.

#### Division of simple Surd Roots.

I. If the Surds are Similar, Homogeneal, or of the same kind, divide one Number, or Quantity, by another, and prefix the common Radical Sign to the Quotient: But if they are Heterogeneal, or not of the same kind, they must be *reduced* before they can be divided.

Thus,  $\sqrt{9} \sqrt{576}$  ( $\sqrt{64} = 8$ . And  $\sqrt[4]{5} (\sqrt[4]{7})$ .

The Demonstration of which General Rule, is the same as that in Multiplication; for from the Nature of Division, the Divisor is to Unity:: as the Dividend to the Quotient. Therefore in our first Instance  $\sqrt{9} \sqrt{1} :: \sqrt{576} \sqrt{64}$ . But as these Roots are, so will their Squares be: That is, 9. 1 :: 576. 64. and that these Numbers are truly Proportional, is apparent; because the Rectangles of the Extremes and Means are equal: Wherefore,  $\sqrt{9} \sqrt{1} :: \sqrt{576} \sqrt{64}$ . and consequently 64 is the true Quotient.

II. If any Rational Quantity to be divided by its Square Root, the Square Root will be the Quotient: For if  $ab$  be divided by  $\sqrt{ab}$ , the Quotient must be  $\sqrt{ab}$ : And if 50 be divided by  $\sqrt{50}$ , the Quotient will also be  $\sqrt{50}$ . Also if any Rational Quantity be to be divided by a Surd, that Rational Quantity must first be reduced to the Form of a Surd, by *Rule 1*.

III. When a Surd Root having a Rational Quantity prefixed before it, is to be divided by the Surd Part of it, the Quotient will be the Rational Quantity. Thus, if  $5\sqrt{9}$ , be to be divided by  $\sqrt{9}$ , the Quotient must be 5: As if  $5\sqrt{9}$  had been divided by 5, the Quotient would be  $\sqrt{9}$ .

IV. When the Dividend and Divisor are the Products of two Rational Quantities multiplied severally into one common Surd; or when they are Rational Quantities prefixed before one common Surd; then divide the Rational Part of the Dividend, by the Rational Part of the Divisor, and what results, is the true Quotient.

Thus, if  $8\sqrt{5}$  be divided by  $2\sqrt{5}$ , the Quotient will be 4, and if  $8\sqrt[3]{7}$ , be divided by  $4\sqrt[3]{7}$ , the Quotient will be only 2.

V. But when the Dividend and Divisor are two Rational Quantities, or Numbers prefixed to two unequal Surds; then you must divide, not only as before, the Rational Part of the Dividend by that of the Divisor, but also the Surd Part; and those two Quotients connected together, so as the Rational Part stand on the Left-hand, are the true Quotient sought.

Thus, if  $4\sqrt{15}$  were to be divided by  $3\sqrt{5}$ , the Quotient will be  $2\sqrt{3}$  ( $= \sqrt{12}$ .) and if  $4\sqrt{12}$ , were to be divided by  $3\sqrt{2}$ , the Quotient will be  $\frac{4}{3}\sqrt{6}$ .

#### Addition and Subtraction of Surd Roots.

I. When two or more Simple and Equal Surds are to be added, multiplied one of them by the Number of them all, and the Product is the Sum required.

Thus, The Sum of  $\sqrt{5}$ , and  $\sqrt{5}$ , is the  $\sqrt{20}$ ; because  $\sqrt{5}$ , multiply'd by 2, the Number of the Surds, that is by  $\sqrt{4}$ , gives  $\sqrt{20}$  their Sum. Also the Sum of  $\sqrt[3]{7} + \sqrt[3]{7}$ ,  $+ \sqrt[3]{7}$ ; because the Surds are 3 in Number, is  $\sqrt[3]{189}$ ; because  $\sqrt[3]{7}$  multiplied by 3 (*i. e.*) the  $\sqrt[3]{7}$  of 27 makes  $\sqrt{189}$ .

II. But if Unequal Simple Surds of the same kind are to be added together, or if one to be subtracted from the other, you must first try whether they are Commensurable; and if they be, that is, if when they have been divided by their greatest common Divisor, their Quotients are Rational Quantities, then you must multiply the Sum of those Rational Quantities by the said Common Divisor, and the Product will be the Sum of the Surds proposed: Or if the Difference of those Rational Quotients be multiplied by the common Divisor, then the Product will be the Difference of the given Surds, when the less is taken from the greater.

Thus, if the Sum or Difference of these two Surds,  $\sqrt{50}$ , and  $\sqrt{8}$ . were required; because they are unequal, I try first, whether they are Commensurable or not, by dividing each by the greatest common Divisor  $\sqrt{2}$ . And the Quotients are  $\sqrt{25}$  and  $\sqrt{4}$ ; that is 5 and 2, which are Rational Numbers; and therefore the Surds are Commensurable: Then their Sum 7, or their Difference 3, multiplied by the common Divisor  $\sqrt{2}$ , produces  $7\sqrt{2}$  for the Sum, and  $3\sqrt{2}$  for the Difference of the Surds required.

III. If the Commensurable Surds proposed, had been Fractions, or mixt Numbers, reduced to the Form



Form of Fractions; they must (if they have not one) be reduced to a common Denominator in the least Terms; and then to find out the Rational Quotients, you need only divide the two New Numerators, by their greatest common Divisor; and then you must go on as above, in *Integral Surds*.

Thus, If the Sum and Difference of  $\sqrt{\frac{24}{25}}$  and  $\sqrt{\frac{2}{3}}$  were required: When reduced to a common Denominator, they will be  $\sqrt{\frac{72}{75}}$  and  $\sqrt{\frac{50}{75}}$  and these divided by their greatest common Divisor:  $\sqrt{\frac{2}{75}}$  the Quotients are  $\sqrt{\frac{36}{75}}$  and  $\sqrt{\frac{25}{75}}$  or  $6\sqrt{\frac{2}{75}}$  and  $5\sqrt{\frac{2}{75}}$ , whose Sum is  $\sqrt{11\frac{2}{75}}$  and their Difference  $\sqrt{\frac{2}{75}}$ .

IV. If the *Simple Surds* given to be added, or subtracted, are *Incommensurable*, then they can only (generally speaking) be added or subtracted by the Signs  $+$  and  $-$ : For neither Sum nor Difference can be expressed by any single Root. And from this Addition or Subtraction of Simple Surds only by their Signs, arises what they call a *Surd Binomial*, or *Residual Root*.

Thus,  $\sqrt{6} + \sqrt{7}$ , is a *Binomial Surd*, and  $\sqrt{7} - \sqrt{6}$  is a *Residual Surd*.

But from *Prop. 4. and 7 of Euclid's second Book*, there arises a Rule which helps us to find the Sum or Difference of *Incommensurable Square Roots*: which is this.

*To or from the Sum of the Squares of the given Surd Roots, add, or subtract, their double Rect-angle; and the Square Root of the Sum, or Remainder, is the Sum or Difference sought, (e. gr.)*

To find the Sum and Difference of  $\sqrt{14}$ , and  $\sqrt{12}$ , their Squares being 14 and 12, their Sum will be 26, and the *Double Rect-angle* of  $\sqrt{14}$ , into  $\sqrt{12}$ , is  $2\sqrt{168}$ . Wherefore

$\sqrt{26 \pm 2\sqrt{168}}$  is the  $\left\{ \begin{array}{l} \text{Sum} \\ \text{Difference} \end{array} \right\}$  required.

#### Of Compound Surds.

The Arithmetick of *Compound Surds* depends on the Rules above given about *Simple Surds*, and on the true Knowledge of the Signs  $+$  and  $-$  in Algebraick Addition, Subtraction, Multiplication, and Division; only some particular Directions may be given as to *Binomials* and *Residuals*: As,

I. If any *Binomial* be to be multiplied by its corresponding *Residual*, the Difference of their Squares is the true Product; and therefore will come out a *Rational Quantity*, as if  $\sqrt{a + e}$  be multiplied by  $\sqrt{a - e}$ , the Product will be a *Rational Quantity*, viz.  $aa - ee$ .

II. Involution in *Binomials* and *Residuals*, is best and most easily performed by a Table of Powers:

As because we see that  $aa + 2ae + ee = (a + e)^2$ . We may conclude, That to Square any *Binomial* whatsoever, you need only add the double *Rectangle* of the Parts to the Sum of the Squares of those Parts; or take the double *Rectangle* from that Sum, if it be a *Residual*.

III. For Division in *Compound Surds*, 'tis convenient, if not necessary, to reduce them first to some better, and when it can be done, to a *Rational Form*. And,

(1.) If a *Binomial*, consisting of two *Simple Square Roots*, or of one *Square Root*, and a *Rational Quantity*, be multiplied by its corresponding *Residual*, the Product will always be a *Rational Quantity*.

(2.) If a *Binomial*, consisting of two *Biquadratick Simple Roots*, or of one *such*, and a *Rational Quantity*; if this be multiplied by its corresponding *Residual*, the Product will be a *Residual* consisting of either two *Square Roots*, or else of one *Square Root* a *Rational Quantity*; which *Residual* being multiplied, as is before said, by its *Binomial*, it produces a *Rational Quantity*.

(3.) If a *Trinomial*, having three *simple Square Roots*, be multiplied by itself, with one of the Signs changed; the Product will be either a *Binomial*, or *Residual*; which being multiplied by its correspondent *Residual*, or *Binomial*, will give in the Product a *Quantity* entirely *Rational*.

IV. If a *Binomial* or *Residual*, consisting of two *Simple Cubick* or *Biquadratick Roots*, &c. or of one *Cubick* or *Biquadratick Root*, &c. and a *Rational Quantity* is proposed for a Divisor; find so many continual Proportionals in the Proportion of the Parts of the *Binomial* or *Residual* proposed, as there be Units in the Index of the Radical Sign, and such whose Radical Sign may be the same with that of the Parts of the *Binomial* or *Residual*; but conjoined in the *Binomial* by  $+$ , and in the Proportionals by  $+$  and  $-$  alternately; or contrarily, in the Proportionals by  $+$ , and in the *Residual* by  $+$  and  $-$ ; the Product of the said Proportionals, so connected, multiplied into the *Binomial* or *Residual*, will be a *Quantity* entirely *Rational*. After the same manner may a *Binomial* or *Residual*, having 5 or 6, &c. for the Index of a common Radical Sign of the Roots, be reduced to a *Quantity* entirely *Rational*.

And *Note*, That when the Roots are of Different Kinds, they must first be reduced to a common Radical Sign.

V. If the Divisor be a *Simple Quantity*, divide each Part of the Dividend by the Divisor, and connect those particular Products together by their Signs; but if the Divisor be a *Binomial*, *Trinomial*, or *Quadrinomial*, &c. of such Kind as before is specified, reduce that given Divisor to a new Divisor that may be a *Simple Rational Quantity*. Reduce also the given Dividend to a new Dividend, by multiplying the former by the Quantities that were Multipliers, in reducing the given Divisor to a *Rational Quantity*; then divide the new Dividend by the new Divisor: But when the Divisor cannot be reduced to a *Simple Rational Quantity*, set the Dividend as a Numerator, over the Divisor as a Denominator.

Thus,



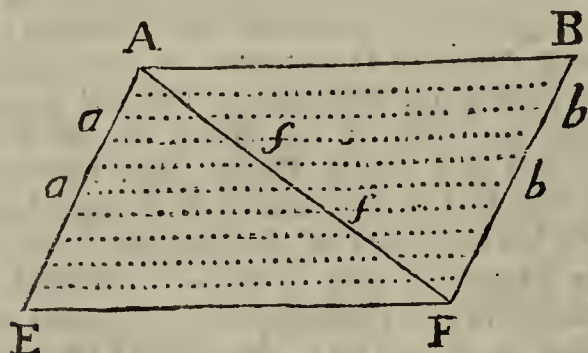
Thus,  $12 \div \sqrt{3} : 63$  divided by 3, the Quotient is  $4 \div \sqrt{3} : 7$ ; and  $8 \div \sqrt{3} : 12$  divided by 2, the Quotient is  $4 \div \sqrt{3} : 3$ ;  $\sqrt{3} : 21 \div \sqrt{3} : 15$  divided by  $\sqrt{3} : 3$ , the Quotient is  $\sqrt{3} : 7 \div \sqrt{3} : 5$ ;  $\sqrt{3} : 56 \div \sqrt{3} : 24$  divided by  $\sqrt{3} : 6$ , the Quotient is  $\sqrt{3} : 9 \frac{2}{3} \div \sqrt{3} : 2$ ; and  $\sqrt{3} : 28 \div \sqrt{3} : 14$  divided by  $\sqrt{3} : 7$ , the Quotient is  $\sqrt{3} : 4 \div \sqrt{3} : 2$ .

**SURETY** of the Peace (so called, because the Party that was in fear, is thereby secured) is an acknowledging of a Bond to the Prince taken by a competent Judge of Record, for the *Keeping of the Peace*. This *Peace* may a *Justice of the Peace* command, either as a Minister, when he is commanded thereto by a higher Authority; or as a Judge, when he doth it of his own Power, derived from his Commission. *Surety of the good abearing*, differs from this, That whereas the *Peace* is not broken without an Affray, or such like; the *Surety de bono gestu* may be broken by the Number of a Man's Company, or by his or their Weapon and Harnes.

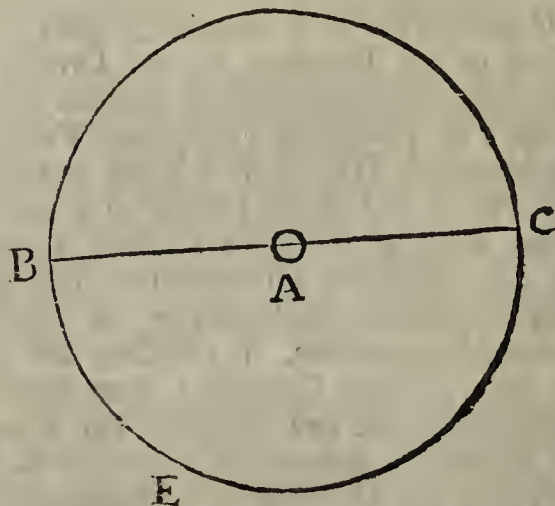
**SURFACE** (the same with *Superficies*) is the bare outside of any Body; and considered by itself, is Quantity extended in Length and Breadth only, without Thickness.

There are *Plane Surfaces*, and there are *Crooked* or *Curved* ones.

A *Plane Surface* or *Superficies*, is made by the Motion of a *Right Line* always keeping in the same Plane.

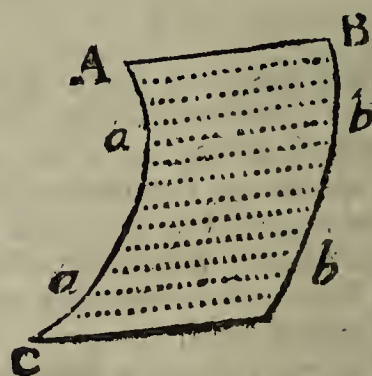
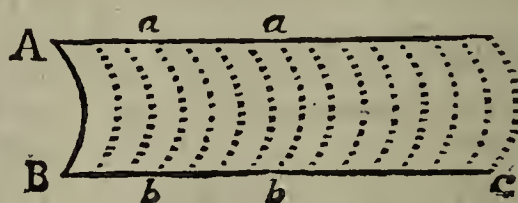


Thus, if the Line AB be conceived to move (with a Motion parallel to itself in its first situation) in the same Plane downward, and at last to stop in the Position EF, it will describe the Plane Figure or Surface ABFE, which is called a *Parallelogram*: As also the two Plane Figures or Surfaces ABF and AEF, which are called *Triangles*.



Also, if the Right Line CA having one end as A fix'd as on a Centre, be moved quite round in the same Plane, 'till the Point C come to C again; this Line will by its Motion describe a *Plane Figure* or *Surface*, which is called a *Circle*, as CEBA.

*Curved Surfaces*, are *Convex* above or without; and *Concave* below or within: You may conceive them like the *Tilt* of a *Boat* or *Waggon*; And such Surfaces may be generated either by the Motion of a *Right Line* on a *Curve*, or a *Curve Line* on a *Right one*, v. gr. In the Figure.



Let the Curve Line AaaC represent the Hoop keeping up the Cloth of a Waggon or Boat; and let the Line AB represent the Gunnel or the upper Edge of the Boat's-side, or the upper Rail of the Waggon. 'Tis plain that if you conceive either the Right Line AB to move up along the Hoop AaaC 'till it come to the Top, and then down again on the other side, 'till it come to the Bottom, it will by its Motion describe the Figure of the Tilt or curved Surface AbbaA. And the very same Figure would be produced by the Motion of one of the Hoops or crooked Line AaaC, carried (in a Position parallel to itself) along the Edges of the Boat or Waggon.

**SURFACE Line**, or Line of *Superficies*, is a Line placed by Mr. Gunter on each Leg of his Sector; it is divided into 100 unequal Parts, and numbred with 1, 2, 3, 4, &c. to 10. See *Superficies*.

**SURGE**, the Sailors call a Wave or Billow of the Sea a *Surge*; also when they are Heaving at the Capstan, if the Cable happen to slip back a little, they say the *Cable Surges*.



**SURMONTE**, in *Heraldry*, is a Chief that has another very small Chief over it of a different Colour or Metal, and therefore is said to be surmounted, as having another over it; see the *Escutcheon*.





**SURMOUNTED.** The Herald's Term for Bearing of one Ordinary upon another. A Pile surmounted of a Chevron.

**SURPLUSAGE**, in Common Law, signifies a Superfluity or Addition more than needeth, which sometimes is the cause that a Writ abateth. It is sometimes also applied to matter of Account, and denotes a greater Disbursement than the Charge of the Accountant amounteth unto.

**SURREJOYNDER**, is a second Defence of the Plaintiff's Action, opposite to the Defendant's *Rejoinder*.

**SURREBUTTER**, is a second *Rebutter*, or a *Rebutting* more than once.

**SURRENDER**, is an Instrument in Writing, testifying with apt Words, That the particular Tenant of Lands or Tenements for Life or Years, doth sufficiently consent and agree, That he which has the next or immediate Remainder or Reversion thereof, shall also have the present Estate of the same in Possession, and that he yields and gives up the same unto him; for every *Surrender* ought forthwith to give Possession of the things *surrendered*. There may be also a *Surrender* without Writing; and therefore there is said to be a *Surrender in Deed*, and a *Surrender in Law*: A *Surrender in Deed*, is that which is really and sensibly performed: A *Surrender in Law*, is Intendment of Law by way of Consequent, and not Actual. As if a Man have a Lease of a Farm, and during the Term he accept of a new Lease; this Act is in Law a *Surrender* of the former: There is also a *Customary Surrender* of the Copyhold Land, as may be seen in *Cooke sup. Littleton*, Sect. 74.

**SURROGATE**, signifies one that is substituted or appointed in the room of another, most commonly of a Bishop, or of a Bishop's Chancellor.

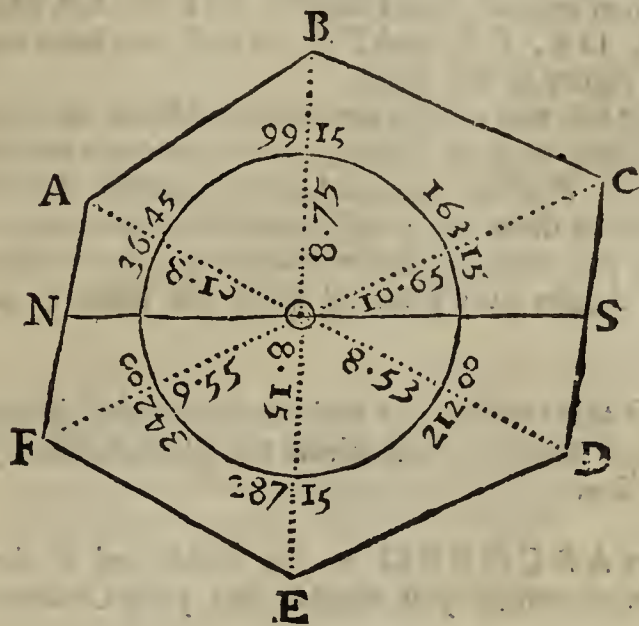
**SURSOLID-Place.** See *Place-solid*.

**SURSOLID-Problem**, in Mathematicks, is that which cannot be resolved, but by Curves of a higher Nature than a Conick Section, *v. gr.* In order to describe a *Regular Endecagon*, or Figure of eleven Sides in a Circle, 'tis required to describe an Isosceles Triangle on a Right Line given, whose Angles at the Base shall be Quintuple to that at the Vertex, which may easily be done by the Intersection of a Quadratrix, or any other Curve of the second Gender, as they are called by some.

**SURVEYING of Land, or Planometria**, is the Art of Measuring all manner of Plane Figures, in order to know their superficial Content; which how to do Geometrically, I have shewed all along under the particular Name of each Plane Figure. But how to bring this to Practice, so as to Measure the Areas of Real Lands, Fields, Grounds, &c. by the help of proper Instruments, is what we usually call *Surveying*; and this is what is design'd to be taught under this Word. The Surveyor being furnished with a good Instrument to take Angles, as a well made Theodolite, or entire Brass Circle, with a well graduated Limb, and Telescope Sights, as also with a well divided Pole-Chain, an Off-set Rod, Station-Staves, &c. He may proceed after these or such like Methods, which a little Practice will familiarize to him.

1. To take the Plot of a Field at one Station in any Place thereof, from whence you may see all the Angles.

Suppose *ABCDEF* to be a *Field*, of which you are to take the *Plot*: Having set your Instrument in any convenient Place thereof, as at  $\odot$ ; and let Marks or Station-Staves with Paper be set up in every Angle: Then set your Instrument so that the Needle hang directly over the *Meridian-Line* of the *Chord*, and there screw fast the Instrument.



Then direct your *Sights* to A, and you will find the *Index* cutting  $36^{\circ} 45'$ , which note down in your *Field-Book* in the second Column thereof, and measure the Distance from  $\odot$  to A, containing suppose 8 *Chains* and 10 *Links*, which set down also in the third Column of your *Field-Book*.

Then direct your *Sights* to B, the *Index* cutting 99 Deg. 15 Min. and the Distance from  $\odot$  to B, is 8 *Chains* and 75 *Links*, both which set down in your *Field-Book*, as before.

Do the like for the rest of the *Angles* from  $\odot$  to C, D, E, and F, and set them down, as you observe them with their Distances measured from the Station, as you see done in this following Table, which is a Copy of the *Field-Book*, and will shew you the Method how to Note down your Observations.

|   | D.  | M. | Ch. | Lin. |
|---|-----|----|-----|------|
| A | 36  | 45 | 8   | 10   |
| B | 99  | 15 | 8   | 75   |
| C | 163 | 15 | 10  | 65   |
| D | 212 | 00 | 8   | 53   |
| E | 287 | 15 | 8   | 15   |
| F | 342 | 00 | 9   | 55   |

Having thus finished your Work in the *Field*, the next Business must be to *Protract* the same; that is to lay down a *Plot* thereof upon Paper or Parchment, which is done thus.

Draw a Line, as N S, representing the *Meridian-Line*; then in part of that Line, as at  $\odot$ , make a Point, representing your Place of standing in the *Field*; upon this Point place the Centre of your *Protractor*, so that the Diameter thereof may be directly upon the Line N.S.

Then against  $36^{\circ} 45'$  on the Limb of the *Protractor*, set a Point representing the Degrees of your first observed Angle, and let the same be done with the second and third Observations.

To prick off the 4th, *viz.* 212. the *Protractor* must be turned downwards, because the Degrees



are greater than a Semicircle. Then proceed to *protract* the rest of the Angles.

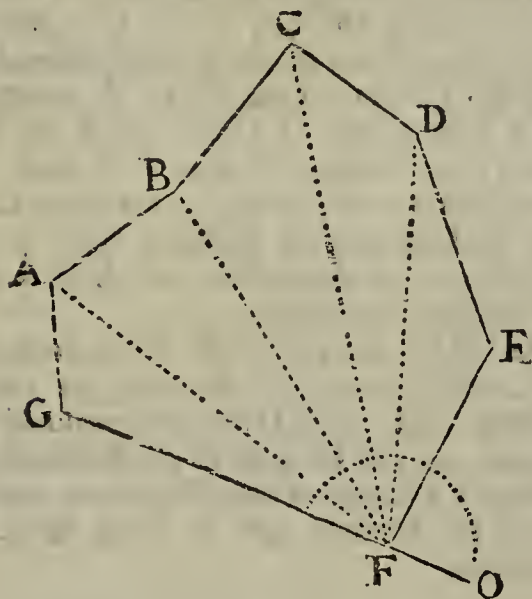
Then take away the *Protractor*, and laying a Ruler to the Station-point  $\odot$ , draw obscure Lines from thence to those Points, on which Lines set their respective Measures from your Scale; as 8 *Chains* 10 *Links* from  $\odot$  to A, and 8 *Chains* 75 *Links* from  $\odot$  to B, and so of the rest, as you have them down in your *Field-Book*.

Then connect these Points by the Lines AB, BC, CD, DE, EF, and FA, so shall you have the true Figure of the Field.

But this way obliges you to more Measuring with the Chain than is needful, and therefore is not so good for Practice in most Cases as another I shall by and by shew you; only it hath this Advantage, That you may soon know whether you have taken your Angles truly; for all about the Point  $\odot = 360^\circ$ .

2. To take the Plot of a Field at one Station, in any Angle thereof, from whence the other Angles may be seen.

Let ABCDEFG be the *Field*, and F the Angle at which you would take your Observations.



Having placed your Instrument at F, turn it about (the North Point of the Card from you) 'till through the *Sights* you espy the Mark at G; then fasten the Instrument, and move the Index 'till you see the Mark at A, the Deg. cut on the Limb being 20; then move it 'till you see B, where it cuts 40 Degrees: Do the same at C, and there it cuts 60 Degrees; likewise at D 77 Degr. and at E 100 Degr. All these Angles note down in your *Field-Book*; next with the Chain, measure all the Lines running from the Station, as from F to G 14 *Chains*, 60 *Links*, and from F to A, 18 *Chains* 20 *Links*, and of the rest, as you see them in this Table.

| Ang. | D.  | M. | Ch. | Lin. |
|------|-----|----|-----|------|
| G    | 00  | 00 | 14  | 60   |
| A    | 20  | 00 | 18  | 20   |
| B    | 40  | 00 | 16  | 80   |
| C    | 60  | 00 | 23  | 20   |
| D    | 77  | 00 | 16  | 95   |
| E    | 100 | 00 | 8   | 50   |

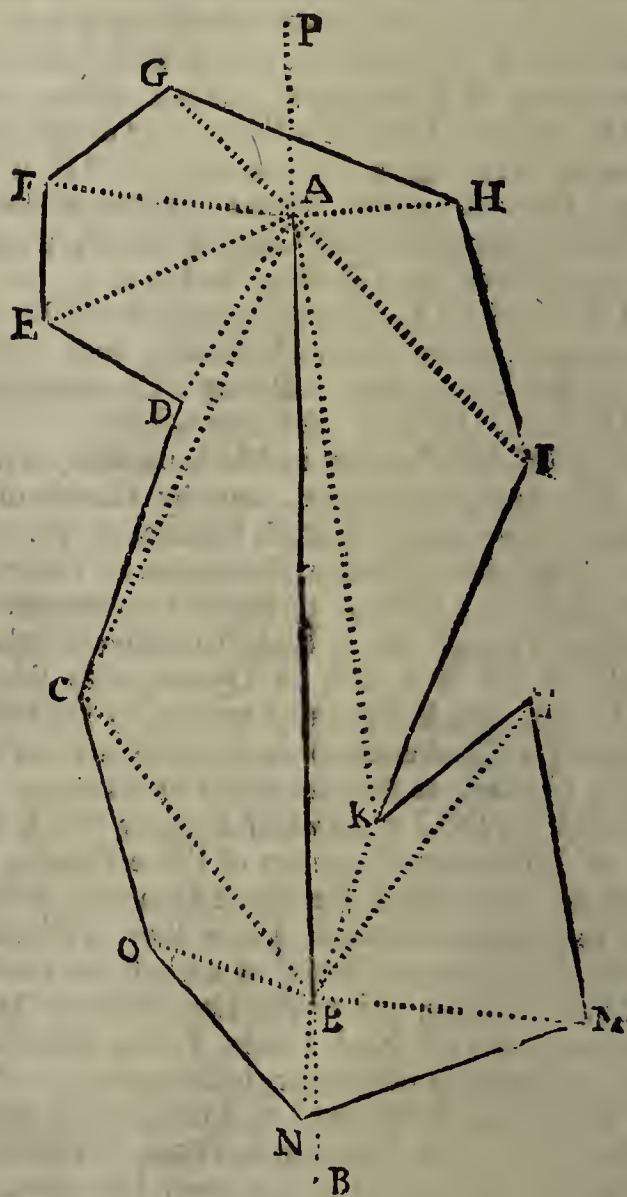
To *protract* these Observations.

Draw a Line at pleasure, as GF, upon which lay the Diameter of your *Protractor*, with the Centre in F; then make Marks at every Angle round the *Protractor*, as you find them in your *Field-Book*, viz. against 20, 40, 60, 77, 100; which done, take away the *Protractor*, and draw Lines FA, FB, FC, FD, and FE, through each of these Marks; on which Lines sets off the Distances by a Scale, as you find them in your *Field-Book*; and where the end of those Distances fall, let there be Lines drawn to connect them, as GA, AB, BC, CD, DE, EF, and FG, and you have your *Field* compleat.

Note, That you may as well take the Plot of a Field at one Station, standing on any Side thereof, as in an Angle.

3. To take the Plot of Field at two Stations, when the Field is so irregular, that from one Station you cannot see all the Angles.

Let CDEFGHIKLMNO be the *Field*, in which from no one Place thereof all the Angles may be seen. Therefore chuse two Places for your Stations, as A and B.



Set your Instrument at A, and look through the *Sights* towards your second Station C, and then fix your Instrument. And, as before taught, with the Index take all the *Angles* at that end of the *Field*, as CDEFGHIK, and measure the Distance between your Instrument and each Angle, as also the Distance between the two Stations.

Then



Then remove your Instrument to the second Station B, and having made it fast, so as through the *Back-Sights* you may see the first Station A, take the Angles at the end of the *Field*, as N O C K L M, and measure their Distances, as before: All which being done, your *Field-Book* will stand thus.

*First Station.*

|      | D. M.  | Ch. Lin. |
|------|--------|----------|
| Ang. | 25 00  | 20 75    |
| C    | 31 00  | 8 10     |
| D    | 67 00  | 9 85     |
| F    | 101 00 | 10 80    |
| G    | 137 00 | 7 00     |
| H    | 262 00 | 6 70     |
| I    | 316 00 | 13 70    |
| K    | 354 00 | 24 50    |

The Distance between the two Stations A and B is 31 Ch. 60 Lin.

*Second Station.*

| Aug. | D. M.  | Ch. Lin. |
|------|--------|----------|
| N    | 3 30   | 4 20     |
| O    | 111 00 | 7 00     |
| C    | 145 00 | 15 60    |
| K    | 205 00 | 8 40     |
| L    | 220 00 | 15 00    |
| M    | 274 00 | 11 20    |

To *Protract* this, draw a Right Line at adventure, as P A B B, whereon set from your Scale 31 Ch. and 60 Links (the Distance between the two Stations) making Marks with the Compasses, as A and B for your first and second Station.

Lay the *Protractor* to A, the North-end of the Diameter being towards B, and mark out the several Angles observed at your first Station, draw Lines, and set off the Distances measured.

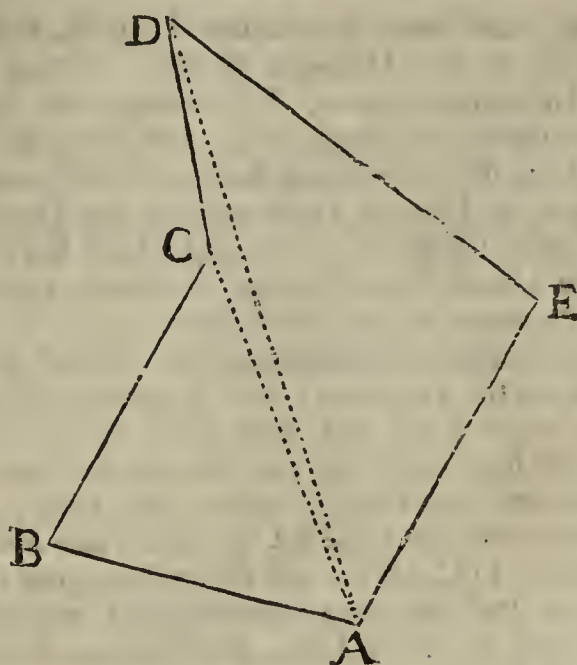
Do the same at B, the second Station; and when you have marked out all the Distances between those Marks, draw the Bound-lines.

*Note*, If a *Field* be very irregular, you may after the same manner make 3, 4, or 5 Stations, if you please: Though 'tis much better to go round such a *Field*, and measure the Bounding-Lines.

4. To take the Plot of a *Field* at one Station, in an Angle (so that from that Angle you may see all the other Angles) by Measuring round about the said *Field*.

Suppose A B C D E the *Field*, and A the Angle appointed for the Station.

Place your Instrument in A, and turn it round 'till you see (through the *fixed Sights*) the Mark at B; then screw it fast, and turn the Index to C, observing what Degrees are there cut on the Limb, which suppose to be 68 Degrees; turn it further,



'till you see D, and Note down the Degrees there cut, viz. 76 Degrees; do the like at E, and the Index will cut 124 Degrees: This done, measure round the *Field*, noting down the Length of the Side-Lines between Angle and Angle.

Then your *Field-Book* will stand thus.

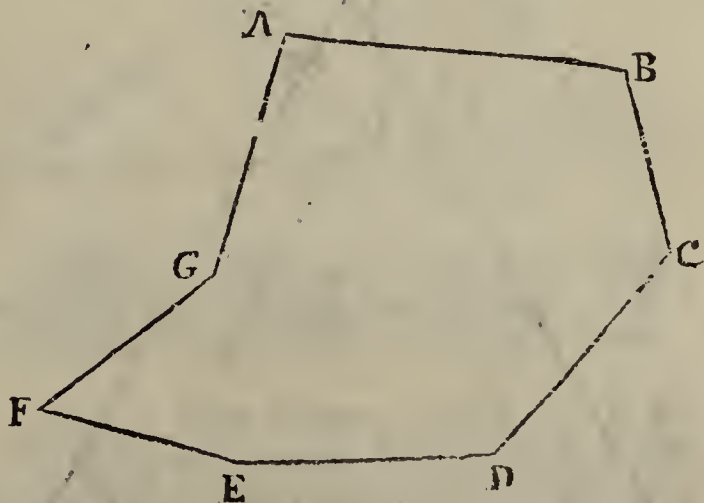
| Ang. | D. M.  |
|------|--------|
| C    | 68 00  |
| D    | 76 00  |
| E    | 124 00 |

| Lines. | Ch. Lin. |
|--------|----------|
| A B    | 14 00    |
| B B    | 15 00    |
| C D    | 7 00     |
| D E    | 14 40    |
| E A    | 14 05    |

To *Protract* which, draw the Line A B as you please, and applying the Centre of the *Protractor* to A (the Diameter lying upon the Line A B) prick off the Angles, and make Marks, through which draw Lines A C, A D, and A E, in which you may find the Points C, D, E, by the Measures taken, as you have them in your *Field-Book*, and taken off a Scale; then draw the Bounding-Lines, and you have done.

5. To take the Plot of a *Park*, *Wood*, a very great *Common*, or a large *Champion Field*, by going round about the same, and making *Observations* at every Angle thereof.

Let A B C D E F G be a large *Field* or *Wood*, through which you cannot see to take the Angles, but must be forced to go round the same.





Place your Instrument at the Angle A, and lay the Index on the Diameter thereof, moving the whole Instrument about, 'till through the Sights you see the second Angle at B, and there fix it: Then turn the Index about backwards 'till you see the Angle at G, the Index cutting 97 Degrees, which is the Quantity of the Angle G A B; measure the Line A B, it contains 12 Chains, 5 Links, which set down in your *Field-Book*.

Then remove your Instrument to B, the Index lying upon the Diameter; turn it about 'till you see the Angle at C, and there fasten it; and turn the Index backwards 'till you see the Angle at A; then set down the Degrees cut on the Limb, and the Measure of the Line B C in your *Field-Book*.

Remove to C, D, F, and G, making your Observations after the same manner; and measuring the Length of every Line, they'll stand thus in the *Field-Book*.

|   | D. M.  | Ch. Lin. |
|---|--------|----------|
| A | 97 00  | 12 5     |
| B | 120 30 | 4 45     |
| C | 132 00 | 8 85     |
| D | 125 00 | 13 4     |
| E | 121 30 | 7 70     |
| F | 80 00  | 5 67     |
| G | 227 00 | 7 87     |

The manner of *Protracting* this, is nearly the same as before.

*How to discover whether the Angles made at their several Stations, be truly taken or not.*

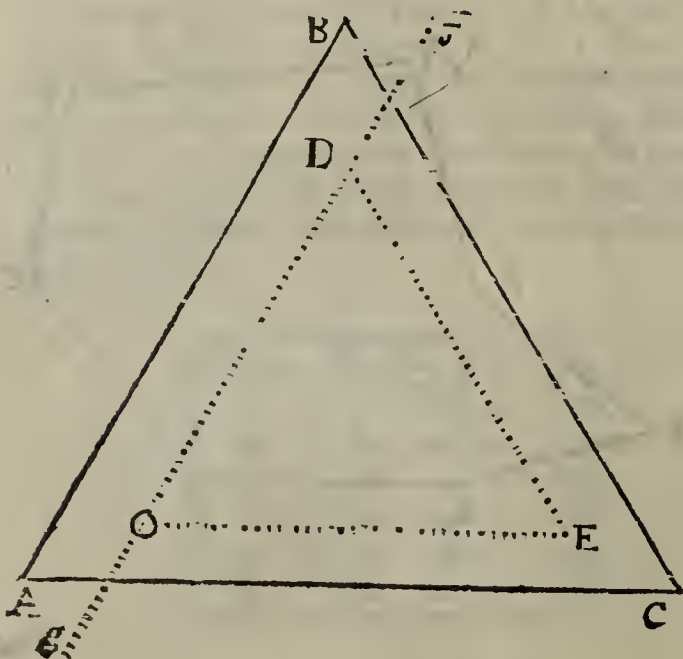
#### R U L E.

Multiply 180 Deg. by a Number less by 2 than the Number of Sides or Angles in your *Plot*, the Product shall be equal to the Sum of all the Angles observed, if you have wrought true, otherwise not.

Thus, there were seven Angles or Sides in the last *Plot*; therefore I multiply 180 by 5, the Product is 900, which is equal to all the Angles reckoned in the inside of the *Plot*: For the outward Angles are not included in the Rule.

6. *To measure parallel to a Hedge (when you cannot go close along the Hedge itself) and also in such a case, how to take your Angles.*

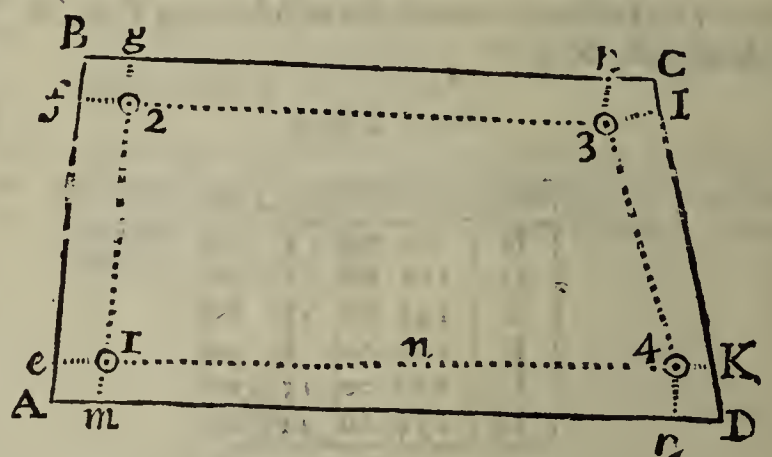
Suppose A B C to be a Field, and for the Bushes you cannot come nigher than O to plant your Instrument.



Then set up Marks, and with your Off-set Rod or Chain, if the Distance be large, take the Distance between the Instrument O, and the Hedge A B; which Distance set off again nigh B, and set up Marks at D: Likewise take the Distance between O and the Hedge A C, and accordingly set up Marks at E. Then take the Angle D O E, which will be the same as the Angle B A C: Do thus for the rest of the Angles. But when the Lines are measured, they must be measured of the same Length with the outside Lines, as the Line O D, measured from g to f.

7. *To take the Plot of a Field or Wood, by observing near every Angle, and measuring the Distance between the Marks of Observation, by taking in every Line, two Off-sets to the Hedge.*

Suppose A B C D to be a Wood or a Field to be thus measured.



Let Marks be set up in every Angle, not regarding the Distance from the Hedges, so much as the Convenience for planting the Instrument, so as you may see from one Mark to another. Then beginning at O 1, take the Quantity of that Angle, and measure the Distance 1, 2. But before you begin to measure the Line, take the Off-sets to the Hedge, viz. the Distance O e; and in taking of it, you must take that Line O e perpendicular to 1, 2, by directing the Diameter of your Instrument towards 2, and turning the Index 'till it lie upon 90 Degrees, which then will point to what place of the Hedge to measure to, as e: Then set the Measure of the Line O e in your *Field-Book* under Title *Off-set*. So likewise when you come to 2, measure the Line 2, 3, and the Off-sets 2 g, 3 h: Do the like by all the rest of the Lines and Angles in the Field, how many soever they be.

And when you come to lay this down upon Paper; first (as before directed) protract the Figure 1, 2, 3, 4. That done, set off your Off-sets, as you find them in your *Field-Book*, viz. O e, and O f perpendicular to the Line 1, 2; also O g and O h perpendicular to the Line 2, 3; making Marks at e, f, g, h, &c. through which draw Lines, which shall intersect each other at the true Angles, and describe the true Bound-Lines of the Field or Wood. And then if many intermediate Off-sets between Angle and Angle be taken, when necessary, is the very best and most expeditious Method of Surveying.

In working after this manner, observe,

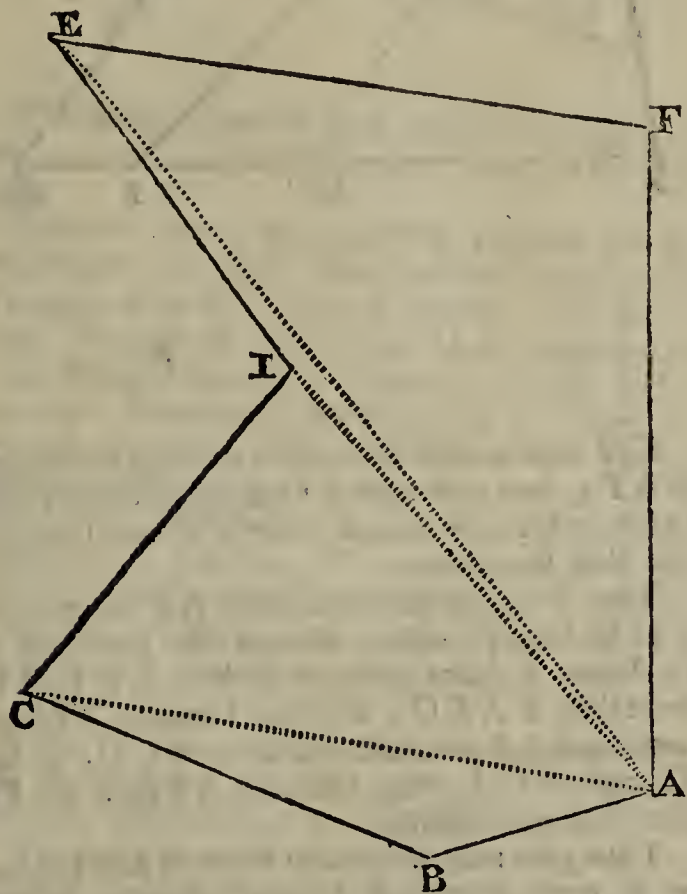
1. If the Wood be so thick, that you cannot work within it, you may then perform the same thing by going on the outside round the Wood.
2. If the Distances are so far, that you cannot see from Angle to Angle, cause your Assistant to set up



up a Mark so far from you as you can conveniently see it, as at  $n$ ; measure the Distance  $\odot n$ , and take the *Off-sets* from  $n$  to the Hedge; and proceed on the Line 'till you come to an Angle.

8. *The common Way used by Surveyors for taking the Plot of a Field by a Chain only.*

Suppose A B C D E F to be the Field, whose Plot is required.



1. Measure round the Field, and note down in your *Field-Book* every Side thereof.

2. Reduce your *Field* into Triangles, by the Diagonals A C, A D, A E, which measure and set down in your *Field-Book*; as suppose them to stand thus.

|                   |   |                |    |    |               |
|-------------------|---|----------------|----|----|---------------|
|                   |   | <i>Ch.Lin.</i> |    |    |               |
| <i>Diagonals.</i> | { | A C            | 33 | 70 | <i>Sides.</i> |
|                   |   | A D            | 25 | 70 |               |
|                   |   | A E            | 45 | 40 |               |
|                   |   |                |    |    |               |
|                   |   |                |    |    |               |
|                   |   | A B            | 12 | 50 | {             |
|                   |   | B C            | 23 | 37 |               |
|                   |   | C D            | 19 | 30 |               |
|                   |   | D E            | 20 | 00 |               |
|                   |   | E F            | 29 | 00 |               |
|                   |   | F A            | 31 | 50 |               |

To Plot which, draw a Line at Pleasure, as A C, whereon set off 33 Ch. 70 Links; then with the Measures of the Sides A B, C B, compleat the Triangle A B C.

Also with the Measures of the Diagonal A D, and the Side C D, compleat the Triangle A D C, upon the same Base C A.

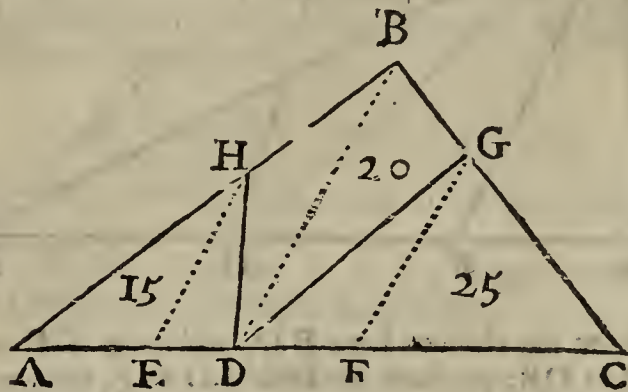
Then with the Measures of the Diagonal A E, and the Side D E, make up the Triangle A D E.

Lastly, Upon the Base A E, with the Measures of the Sides A F, E F, compleat the Triangle A F E. So you have the true Figure of the Field, consisting of four Triangles, which are to be measured by the Direction given under the Word *Chain*.

3. *The Practice of Surveying, as it relates to dividing of Lands.*

To divide a Triangular piece of Land into any Number of equal and unequal Parts, by Lines proceeding from any Point assigned in any Side thereof.

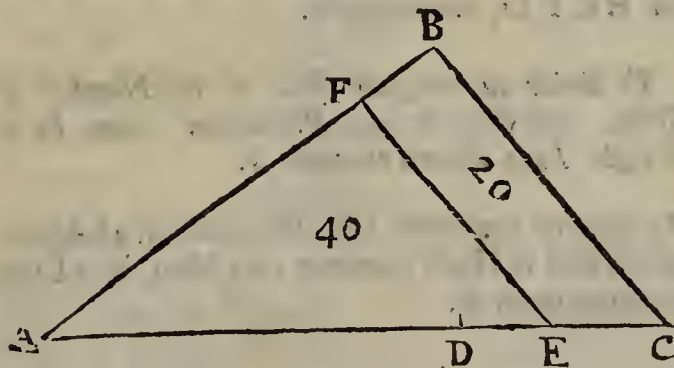
Let A B C D be the Triangular piece of Land, containing 60 Acres, to be divided between three Men: The first to have 15 Acres, the second 20, and the third 25 Acres; and the Lines of Division to proceed from D.



First, measure the Base, which is 50 Chains; then divide this Base into 3 Parts; thus, saying, If 60 give 50, What shall 15 give? Answer, 12 Chains 50 Links for the first Man's Base, which set from A to E. Again, say, If 60 give 50, What shall 20 give? Answer, 16 Chains 66 Links for the second Man's Base, which set off from E to F; Then the third Man's Base must be 20 Chains 84 Links, viz. from F to C. This done, draw an obscure Line from E to the opposite Angle B, and from E and F draw the Line E H and F G parallel to B D. Lastly, from D, draw D H and D G, which shall divide the Triangle into three such Parts as were required.

10. *To divide a Triangular Piece of Land, according to any Proportion given, by a Line drawn parallel to one of the Sides.*

A B C is the Triangular Piece of Land, containing 60 Acres, the Base A C is 50 Chains: This Piece of Land is to be divided between two Men, by a Line drawn parallel to B C, in such Proportion, that one have 40 Acres, the other 20.



1. Divide the Base, as has been before taught, and the Point of Division shall fall in D. A D is 33 Chains 33 Links; D C 16 Chains 67 Links.

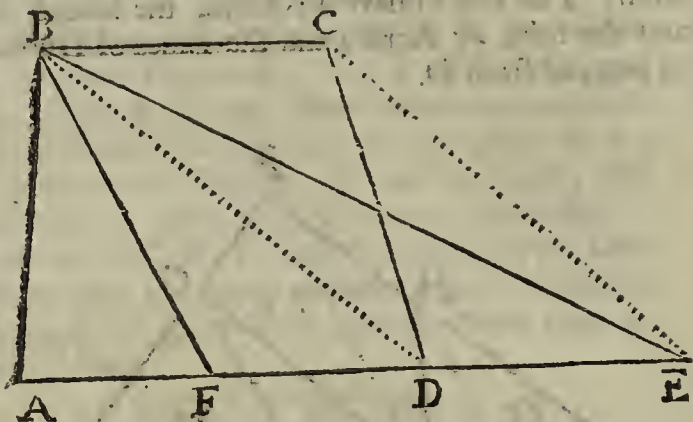
2. Find a mean Proportion between A D and A C, by multiplying the whole Base 50 by A D 33, 33, the Product is 16665000, of which Sum extract the Square Root, 'twill be 40 Ch. 82 Links, which



which set from A to E; then draw ET parallel to BC, so the Triangle is divided as required.

11. To reduce a Trapezia into a Triangle, by Lines drawn from any Angle thereof.

Let ABCD be the Trapezia to be reduced into a Triangle, and B the Angle assigned.



Draw the obscure Line BD, and draw CE parallel to DB; produce the Base AD to E, and draw BE, which shall make the Triangle BAE equal to the Trapezia ABCD.

Now to divide this Trapezia according to any assigned Proportion, is no more but to divide the Triangle ABE, as before taught, which will also divide the Trapezia.

Example.

Suppose the Trapezia ABCD, containing 124 Acres, 3 Rods, and 8 Perches, is to be divided between two Men; the first to have 50 Acres, 2 Rods, and 3 Perches; the other 74 Acres, 1 Rod, and 5 Perches, and the Line of Division to proceed from B.

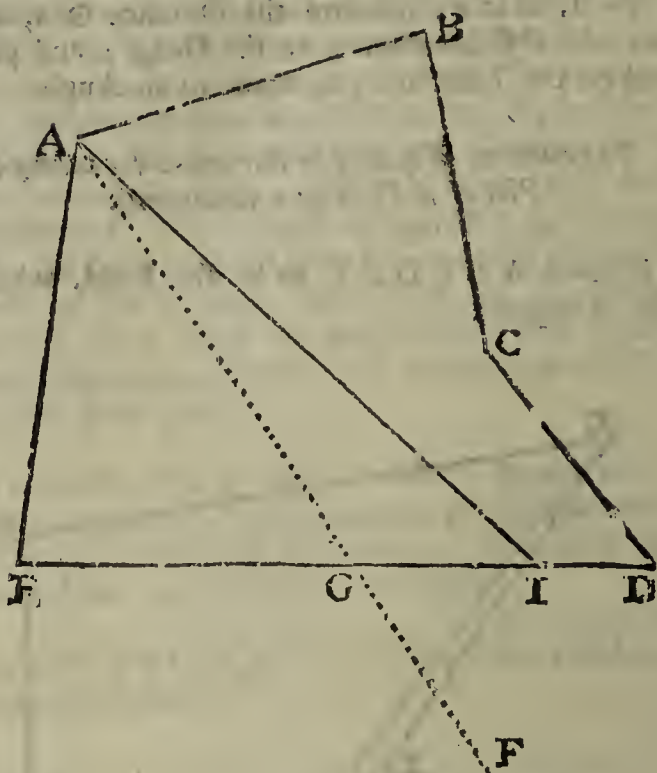
First, Reduce the Shares into Perches, and 'twill be 8083 for the first Man, and 11885 Perches for the second Man's Share.

Secondly, Measure the Base of the Triangle, viz. AE, 78 Chains 00 Links.

Then say, If 19968, the whole Content, give for its Base 78 Chains. What shall 8083, the first Man's Part, give? Answer, 31 Chains, 52 Links; which set off from A to F, draw the Line FB, so you divide the Trapezia as desired: The Triangle ABF being the first Man's Portion, and the Trapezia BCFD, the second's.

12. To divide an irregular Plot of any Number of Sides, according to any Proportion given, by a straight Line drawn through it.

As suppose the Field ABCDE contain 46 Acres, to be divided in Halfs between two Men, by a Line proceeding from A.



First draw a Line at pleasure through the Figure as AF; then cast up the Content of either Half, and see what it wants, or what it is more than the true Half should be.

Thus I cast up the Content of AEG, and find it to be but 15 Acres; whereas the true Half is 23 Acres; 8 Acres being in the Part ABCDG more than in AEG; therefore I make a Triangle containing 8 Acres, and add it to AEG, as the Triangle AGI; then the Line AI parts the Figure into equal Halfs.

Thus you may divide any Piece of Land of never so many Sides and Angles, according to any Proportion, by streight Lines drawn through it, with as much Certainty, and more expeditiously than by any other way yet known.

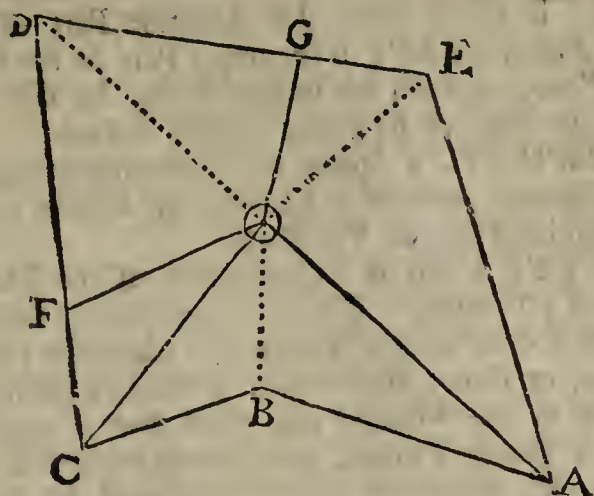
Another Example will make all plain.

Suppose the following Field, containing 27 Acres, is to be divided between three Men, each to have 9 Acres, and the Lines of Division to run from a Pond to a Field, so every one may have the Benefit of the Water, without going over one another's Land.

First, from the Pond @ draw Lines to every Angle, as @A, @B, @C, @D, @E; and then the Figure is divided into 5 Triangles, each of which Measure, and put the Contents down severally; which Contents reduce into all Perches, and so will the Triangle

|       |      |            |
|-------|------|------------|
| A @ B | 674  | } Perches. |
| B @ C | 390  |            |
| C @ D | 1238 |            |
| D @ E | 911  |            |
| E @ F | 1107 |            |





The whole Content being 4320 Perches, or 27 Acres, each Man's Proportion being 1440 Perches.

From  $\odot$  to any Angle draw a Line for the Division-Line, as  $\odot A$ : then consider that the first Triangle  $A \odot B$  is but 674 Perches, and the second Triangle  $B \odot C$  390, both together, but 1064 Perches, less by 376 than 1440, one Man's Portion. You must therefore cut off from the third Triangle  $C \odot D$ , 376 Perches for the first Man's Dividing-Line, which thus you do: The Base  $DC$  is 18 Chains, the Content of the Triangle 1238; say then, If 1238 Perches give bare 18 Chains, What shall 376 Perches give? Answer, 5 Chains, 45 Links; which set from  $C$  to  $F$ , and drawing  $\odot F$ , you have the first Man's Part, viz.  $A \odot F$ .

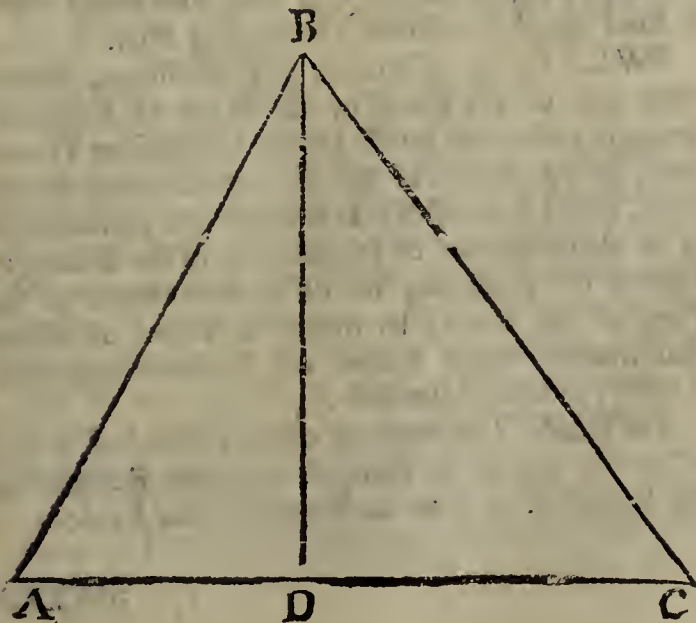
Then see what remains of the Triangle  $C \odot D$ , 376 being taken out, and you'll find it to be 862 Perches, which is less by 578 than 1440.

Therefore from the Triangle  $D \odot E$  cut off 578 Perches, and the Point of Division will fall in  $G$ . Draw the Line  $\odot G$ , which with  $\odot A$  and  $\odot F$ , divides the Figure into three equal Parts.

### 13. To take the Horizontal-Line of a Hill.

When you measure a Hill, you must measure the Superficies thereof, and accordingly cast up the Contents. But when you *Plot* it down, because you cannot make a Convex Superficies upon the Paper, you must only *Plot* the *Horizontal-Line* or *Base* thereof, which you must shadow over with the Resemblance of a Hill. That *Horizontal* or *Base-Line* is found after this manner.

Suppose  $ABCD$  a Hill, whose Base you would know.



Your Instrument being placed at  $A$ , cause a Mark to be set up at  $B$ , so high above the top of the Hill as the Instrument stands from the Ground at  $A$ ; then take the Angle  $BAD$ , 58 Deg. measure the Distance  $AB$ , 16 Chains, 80 Links: Then say,

$$\text{As Rad. : } AB :: S, BAD : AD.$$

$$S, 90^\circ, 00' : 16 \text{ Ch. } 80 \text{ Lin.} :: S, 32^\circ, 00' : 8 \text{ Ch. } 90 \text{ Lin.}$$

Then remove your Instrument to  $B$ , and take the Angle  $CBD$ , 46 Deg. measure the Distance  $BC$  21 Chains; then say,

$$\text{As Rad. : } BC :: S, CBD : DC.$$

$$S, 90^\circ, 00' : 21 \text{ Ch.} :: S, 46^\circ, 00' : 15 \text{ Ch. } 12 \text{ Links.}$$

The 15, 12 added to 8, 90, makes 24 Chains 2 Links, for the whole Base  $AC$ .

Otherwise thus.

Take the Angles  $BAC$  58d. and  $ABC$  78 Deg. subtract these two from 180 Deg. there will remain the Angle  $C$  44 Deg. measure  $AB$ , then say,

$$\text{As } S, C : AB :: S, B : AC.$$

### 14. To find the Content of your Field in Acres and Parts of an Acre.

Since Mr. Gunter's 4 Pole Chain, all along here used, is supposed to be divided into 100 equal Parts or Links; and that every Acre contains 160 Square Perches or Poles. Therefore 160 Perches  $\times$  into 160 Perches, = a Square Acre. But the Chain being decimally divided, so that in one 4 Pole Chain there are 100 Links; therefore 10 Square Chains must make an Acre; that is, an Acre will contain 10000 Links.

Suppose therefore the Base of any Triangle in my Plot were 27 Chains 53 Links, whose Area in Acres and Parts of an Acre I would find by multiplying its half Altitude 8 Chains 25 Links, into that Base or Side: Work just as in Decimals, thus;

$$\begin{array}{r} \text{C. L.} \\ 27 \ 53 \\ \times 8 \ 25 \\ \hline 13765 \\ 5506 \\ \hline 22024 \\ \hline 22 \ 71225 \end{array}$$

Only from the Product I cut off five places (or which is all one, Divide it by 10000) there remains 22 Acres .71225. To reduce which Decimal Fraction .71225 into Roods and Perches, I consider that there are 4 Roods in an Acre; therefore I multiply by 4, and cut off 5 Places as before.

$$\begin{array}{r} .71225 \\ \times 4 \\ \hline 2 \ 84900 \end{array}$$



This gives me 2 Rod and this Fraction;

$$\begin{array}{r} 84900 \\ 40 \\ \hline 33|96000 \end{array}$$

which I multiply by 40, because there are 40 Perches in a Rod, and the Product is 33 96000, from whence cutting off 5 Places, as before, it gives me 33 Perches. So the whole Content is 22 Acres, 2 Rods, 33 Perches. See the Word *Chain*.

*Knowing the Content of a Piece of Land, to find what Scale it is was plotted by.*

First, By any *Scale* measure the Content of the *Plot*; then say,

As the Content found, is to the Square of the *Scale* I tried by;

So is the true Content to the Square of the true *Scale* it was plotted by.

As suppose there is a *Plot* of a piece of Land containing 10 Acres, and I measure it by the *Scale* of 11 in an *Inch*, and find it to contain 12 Acres  $\frac{1}{10}$  of *Acre*.

Then say,

$$\text{As } 12 \frac{1}{10} : 121 (=) \text{Sq.} :: 10 : 103.$$

And the Square Root of 100 is 10; therefore I conclude that *Plot* to be made by a *Scale* of 10 in an *Inch*:

*How to change Customary Measure into Statute Measure, and the contrary.*

Say, As the Square of one sort of Measure, is to the Square of the other:

So is the Content of the one, to the Content of the other.

Thus: Suppose a *Field* measured by a Perch of 18 Foot contain 100 Acres, How many Acres shall the same *Field* contain by a Perch of 16 Foot  $\frac{1}{2}$ ?

Say, If the Square of 16  $\frac{1}{2}$  Foot, viz. 272, 25, give the Square of 18, viz. 324, What shall 100 Acres Customary give? Answer, 119  $\frac{2}{10}$  Statute Acres.

**SURVEYING-*Scale***, the same with *Reducing-*Scale**.

**SURVIVOR**, in Law, signifies the longer Liver of two *Joint-Tenants*, or of any two joined in the Right of any thing.

**SUSPENSION**, or *Suspense*, is a Temporal Stop of a Man's Right; as when a Seignory, Rent, &c. by reason of the Unity of Possession thereof, and of the Land out of which they issue, are not *in esse* for a Time, and *tunc dormiunt*, but may be revived or awaked, and so differs from Extinguishment, which dies for ever. And sometimes this Word Suspension is used in Common Law, as it is in the Canon Law, *pro minori Excommunicatione*.

**SUSPENSION**, in *Mechanicks*, as the Points of Suspension in a Balance are those Points in the Axis or Beam, wherein the Weights are applied, or from which they are suspended.

**SUSPENSOR Testiculi**, the Name of a Muscle, otherwise called *Cremaster*; which see.

**SUSPENSORIUM**, is a Ligament of the *Penis*, first discovered by our Accurate Mr. Cowper the Sur-

geon. It riseth from the Anterior Part of the *Offa Pubis*, and fix'd to the upper Part of the *Dorsum Penis*, on each side its great Vein. Its Use is to assist the *Musculi Erigentes* in their Action.

**SUSPIRAL**, a Spring of Water that passes under Ground towards a Conduit or Cistern; also a breathing Hole or Ventiduct.

**SUTURA** also is a Connexion of the Sides or Lips of a Wound. This is of two sorts: Actual, which is done with a Needle of a triangular Point, a Pipe, or Cane, and waxed Thread: First in the middle of the Wound you must sew it together with a double Thread, and having made a Knot, cut it off; the rest of the Wound must be sewed up with single Thread: Care must be taken that the Stitches are not set too wide, nor too close, especially not too close, that there may be room for any corrupt Matter bred in the Wound to work out. The other sort of Suture is much like the Way that the Skinners use to sew Skins together: This is proper in Wounds of the Intestines, and in Cuts of the Veins and Arteries.

Also the *Junctures* of the Parts of the Shells of Fishes to one another, are called *Sutures*.

**SUTURA Offium**, a Suture in the Junction of the Bones of the Skull, like the Teeth of Saws meeting together. Those which join the Parts of the Skull to the Bones of the upper Jaw, are of 3 sorts; the *Transversalis*, the *Etmoidalis*, and the *Sphenoidalis*; which see under those Words. The Sutures joining the Parts of the Skull are 4: The *Coronalis*, *Lambdoidalis*, *Sagittalis*, and *Squamosa*; which see.

**SWABBER**, the Title of an inferior Officer aboard a Man of War, whose Office it is to see that the Ship be kept neat and clean; in order to which, he is to see her washed well once or twice a Week at least, especially about the Gun-walls and Chains. He ought to burn Pitch or some such thing now and then between Decks, to prevent Infection; and to acquaint the Captain of such as are Nasty and Offensive.

**SWAINMOTE**, or *Swannimote*, signifies a Court touching Matters of Forest, and held by the Charter of the Forest thrice in the Year, before the *Verderors* as Judges. And it is as incident to a Forest, as Court of Pye-powder to a Fair.

**SWALLET**, in the Lead-Mines in *Mendip*, is their Term for a Quantity of Water which breaks in upon them in their Work; when they meet with it, they drive an Adit on a Level 'till it is dry. See *Lead*.

**SWALLOW-Tail**, in Fortification, is a *single Tenaille*, that is narrower towards the Place than towards the Country. See *Queue d'ironde*.

**SWATH**, in *Surgery*, a long and broad Band to bind up any diseased Member or Part.

**SWEAT**, in *Medicine*, is a Moisture, which issues out of the Pores of the Skins of Animals; through either too much Heat, Exercise or Weakness; or by reason of the Actions of those Medicines, call'd Sudorificks. It is either the consequence of an Acceleration of the Motion of the Blood, by *Stimuli* or Exercise, or of a Relaxation of the Pores of the *Cutis*; by means of either of which, that matter which before did Pressure insensible, is now rendered Insensible.

**SWEEP**. The Seamen call the Mold of a Ship when she begins to compass in at the Rungheds, the *Sweep* of her; or the Sweep of the Futtock.



**SWEEPING**, at Sea, signifies dragging along the Ground, at the Bottom of the Sea, or Channel, with a Three-fluked Grapnel, to find some *Hawser* or *Cable*, which is slipped from an Anchor.

**SWEETBREAD**. See *Pancreas*.

**SWIFT** in *Motion*, a Planet is said to be so, when by its own proper Diurnal Motion, he exceeds, or moves further than his mean Diurnal Motion: *Slow in Motion*, is when his Motion happens to be less than his *mean Motion*.

**SWIFTERS**, in a Ship, are Ropes belonging to the Main-masts, and Fore-masts, and help to succour or strengthen the Shrowds, and to keep the Masts stiff: They have Pendants fastened under the Shrowds at the Head of the Masts, with a double Block, through which the Swifter is reeved; which at the *standing Part* hath a single Block with a Hook, hitched into a Ring at the *Chain Wale*; and so the Fall being haled up, helps to strengthen the Mast, and it is belayed about the Timber-heads of the lower Rails aloft.

**SWIFTING** of a Boat, is compassing her Gunwale round with a good Rope, to strengthen her in a Stress of Weather, that she be not shattered by the Violence of the Sea.

**SWIFTING** of a Ship, is either bringing her a-ground, or upon a Caren; for then they use to *Swift the Masts*, to ease and strengthen them, that all the Weight may not hang by the Head; which is done by laying fast all the *Pendants* of the *Swifters* and *Tackles* (with a Rope) close to the Mast, and as near to the Blocks as can be; and then to carry forward the Tackles, and there to *Bowse*, or hale them down as hard and taught as is possible: So that the Sea Word of Command here, is, *Ho! Bowse Men!* All this is done also to keep the Mast from rising out of the *Step*.

**SWIFTING** the *Capstan-Bars*, is straining a Rope all round the outer Ends of the *Capstan-Bars*, in order to strengthen them, and make them bear all alike, and together, when the Men heave or work there.

**SWING-WHEEL**, in a Royal Pendulum-Clock, is that Wheel which drives the Pendulum: This Wheel in a Watch is called the *Crown-Wheel*, as also in a Balance-Clock.

**SYCOSIS** [*σύκωσις*, Gr.] is an Excrescence of the Flesh about the Fundament; 'tis also an Ulcer, so called from the Resemblance of a Fig; this is of two kinds, one hard and round, the other soft and flat; out of the hard issues a very small Quantity of glutinous Matter; out of the moist proceeds a greater Quantity, and of an ill smell: These Ulcers grow in those Parts only which are covered with Hair; the hard and round chiefly in the Beard; the moist for the most part in the Scalp. *Blanchard*.

**SYDERATION**. See *Apoplexy*.

**SYDERIAL Year**. See *Year*.

**SYLLEPSIS** [*σύλληψις*, Gr.] or *Conceptio* (in *Grammar*) is when the Sense of an Expression is to be conceived otherwise than is imported by the Words; and so the Construction is made accordingly, as some define it. But *Vossius* saith, 'tis an Agreement of a Verb or an Adjective, not with that Word which is most near, but with that which is most worthy, honourable, &c. in any Sentence, as *Rex & Regina beati*.

**SYLLOGISM** [*συλλόγισμος*, Gr.] an Argument or Form of Reasoning, which consists of three Propositions, which have this Property, that the

Conclusion follows necessarily from the two Premises; so that if the first and second Propositions are granted, the Conclusion must be granted in like manner, and the whole allowed to be Demonstration.

**SYMBOLS**. See *Characters*.

**SYMMETRICAL**, the same with *Commensurable*.

**SYMMETRY** [*συμμετρία*, Gr.] is usually taken in *Architecture* for the Proportion required, according to the Rules of *Geometry*, to make all the Parts of any Structure completely agree to, and with the Whole.

**SYMPATHETICAL Inks**, are such as can be made to appear or disappear very suddenly by the Application of something that seems to work by Sympathy.

There are some ways of preparing Inks of this Kind, which are really wonderful and surprizing, as well as curious and diverting.

*The Experiments are these.*

Take of good unflaked Lime, two or three Parts, according to the Strength and Goodness of the same, and one Part of *Yellow Orpiment* (which to powder, had best be wrapt up in a thick Paper, and so beaten, to prevent the dangerous Steams that may affect the Head) both these being powder'd and mix'd, put to them 15 or 16 times as much Water in weight as there was of *Orpin*: Stop the Viol well with Cork and Bladder, and set it in warm Embers, or some such Place; shaking the Viol now and then for 4 or 5 Hours; then warily decant the clear Part, or, which is better, *filtrate* it.

In the mean Time burn a piece of Cork thoroughly; and when it is well inflamed, quench it in common Water (or which is better, *Aqua Vitæ*, or *Brandy*) and by this means reducing of it to a friable Coal, grind it with a sufficient quantity of fair Water, in which you have dissolved a little *Gum-Arabick*, and so it will make a Liquor as black as common Ink, which will serve very well to write any thing with.

While these are doing, dissolve in three times as much distilled, or strong Vinegar, over warm Embers, a Quantity of *Red-Lead* (or *Minium*) or of *Saccharum Saturni*, in three times as much Water, for 3 or 4 Hours, or 'till you find the Liquor have a very sweet Taste. This will likewise, as the first Liquor, be clear as common Water.

All things being thus ready (for you must be pretty quick at it) write on a piece of Paper what you will, with this last Liquor, with a clean, or new Pen, and when it is dry, nothing will appear.

Then over that place write with the Ink you made of the Cork, what you please; it will look just as if it had been written with common Ink, which let dry; then dipping a small piece of Rag, or Sponge, in the first Liquor, rub it on the Place written, and you will immediately see the black Writing vanish, and that written with the Invisible Ink, appear Black and Legible.

Take also a Book 4 or 5 Inches thick, and writing on the first blank Leaf with the last Liquor, or the Invisible Ink; or putting in there a Paper so written, turn to the other end of the Book, and rub there with a Rag dipt in the first Liquor, on that part that is as nearly as you can guess, opposite to the Writing, and leave also the Rag there:



And over it clap a folded Paper, and nimbly shutting the Book; strike 4 or 5 good Strokes on it with your Hand; and then turning it t'other side uppermost, clap it into a Press, or lay it between two Boards with a good Weight on it for a Quarter of an Hour (or half that time will do) then taking it out, you'll find the Writing black and legible, which was written with the invisible Ink.

This Process, Mr. Boyle communicated in his *History of Gold*, p. 322. and afterwards Lemery published it in his *Course of Chymistry*, with the Addition of the latter Experiment.

By whose help we may endeavour at a Solution of these strange Experiments, if we consider;

1. That the first of these Liquors is a Mixture of the Alkalizate, and fiery Salt of Quick-lime, with the Sulphureous Substance of the *Orpin*: which is a kind of *Arsenick*.

2. That the Blackness of the Ink, which is the second Liquor, proceeds only from the porous, light, and sooty Parts of the Cork; which are its Oily Parts very much rarified.

3. That the last Liquor (or the invisible Ink) only the Parts of the Lead held up imperceptibly in the acid Liquor of Vinegar.

Hence then, the Reason of the disappearing of the Ink in the first Experiment, is from the penetrating Parts of the first Liquor, which consisting of an Alkalizate Salt, and a penetrating Oil, or Sulphur, doth make a kind of Soap, which soon dissolves the rarify'd Fuliginosity of the Ink, as common Soap takes away greasy Spots out of Cloaths, &c.

And the invisible Ink then appears Black, because the Edges of the acid Liquor that hold the Parts of the Lead dissolved, being now broken by its Conflict with the Alkali of the first Liquor; the Parts of the Lead are, as it were, precipitated on the Paper, and so appear in their proper Colour, which is Black.

So that the visible Ink disappears, because its black Parts are dissolved; and the Invisible doth appear, because its dissolved Parts are revived, or restored.

*The second Experiment shews the strange piercing Subtily of the first Liquor.*

You had best make all the Liquors in different Places, lest they should mingle, and so spoil the Experiment, as I have known them sometimes do.

#### *Experiment the Third.*

Dissolve a little white or green Vitriol in Water; and then write with a clean Pen with the Solution, nothing will appear.

Boil Galls in Water, and dip a Rag of Linnen in the Decoction, and with it rub the Place before written, and it will appear Black and Legible.

But if you rub over it with a Feather, or a Rag dipt in Spirit of Vitriol (or its Oil) the Letters will disappear again.

Dip another Rag in Oil of *Tartar per Deliquium*, and rub on the Place, the Letters will appear again, but of a yellowish Colour. *Lemery's Chymistry*, last Edit. pag. 330.

## R E A S O N S.

*The Coagulum of the Vitriol and Galls, is the Cause of the first Blackness (as is seen in making common Ink) which the acid Spirit of Vitriol dissolves, and so the Letters disappear: But the Oil of Tartar breaking (as it uses to do in all Precipitations) the Force of this acid Spirit, restores the Coagulum, but spoils its Colour a little, by mingling itself with it.*

SYMPATHETICK Powder, is only said (*Lemery*) Green, or *Roman Vitriol*, opened by the Sun-Beams penetrating into it, and imperfectly calcining it: The Vitriol is usually exposed to the Sun's Heat in the Month of *July*, but some use only Powder of Vitriol. When they use it, they spread some of the Powder upon a Linnen-cloth dipt in the Blood of any Wound, and then pretend, that if the Cloth be many Miles off the wounded Person, yet he shall be healed: But this is so far from being true, notwithstanding the vaunting Stories of *Sir Ken. Digby* and others, that 'twill hardly have its Effect, if done in the same Room where the Patient lies; and he is certainly very much wanting to himself, who will use no other Help.

Vitriol hath its Parts in continual Motion; and 'tis probable, many *Effluvia* may go out from it; and some few of those, if Application be made to the Cloth, just by the Patient, may perhaps enter into the Wound, and help to stop the Bleeding; for Vitriol is a known Styptick; but he that will neglect all other Means, and depend only on this, may probably pay dear for his Credulity.

SYMPATHY, is an Agreement of Affections between two or more Persons; some have thought that there is also a Sympathy between some Natural Bodies, or their Particles. But this ought rather to be called a *Congruity*. See that Word.

SYMPATHY, in *Physick*, is an Indisposition that affects one part of the Body, through the Faultiness or Disorder of another.

SYMPEPSIS [συμπεψις, Gr.] is a Coction of those Humours, which are growing into an Impostume.

SYMPHONY [συμφωνία, Gr.] a Consonance or Consort of several Sounds agreeable to the Ear, whether they be Vocal or Instrumental, or both, the same that is called Harmony.

SYMPHYSIS [συμφυσις, Gr.] is the joining of two Bones of which neither has a proper distinct Motion: This is either without any Medium, or else with it, as with a Cartilage, or Gristle, a Ligament, or Flesh, &c.

SYMPTOM [συμπτωμα, Gr.] is a preternatural Disposition of the Body, occasioned by some Disease; this is either a Disease caused by another Disease; or else the Cause of a Disease proceeding from another Disease; or else simply a Symptom: This last is either some Action of the Body hindered, or disturbed, some Fault of the Excrement, or Change of the Natural Temper. *Blanchard*.

SYMPTOMATICAL Fevers, according to some, are those which arise from the Inflammation and Putrefaction of Humours contained in some of the Bowels; of which kind are those Fevers that accompany the *Pleurisy*, *Inflammation of the Lungs and Liver*, *Frenzy*, *Quinsy*, and other Inflammations, as Ulcers of the internal or external Parts.

SYMPTOTES. See *Asymptotes*.

SYNA-



SYNACTICA [συνακτικά, Gr.] are Medicines that contract any Part.

SYNANCHE [συναγχή Gr.] is a sort of *Squintancy*, which quite stops the Breath, or a preternatural Inflammation of the Muscles of the Jaws.

SYNALÆPHA [συναλειφή, Gr.] is a Figure in the Dimension, or Scanning of a *Latin* Verse, whereby there is a Coalition of the two Vowels or Diphthongs, one of which ends, and the other begins two contiguous Words in a Verse, so that they make but one.

SYNARTHROSIS [συνάρθρωσις, Gr.] is a joining of Bones by a Gristle, and is of two sorts, *viz.* *Sutura*, and *Gomphosis*, which see.

SYNCHONDROSIS [of συν with, and χόνδρ Gr.] the same with *Synarthrosis*.

SYNCHYSIS [συνκυσίς Gr.] in *Grammar*, is a confused and disorderly placing of Words in a Sentence.

SYNCHYSIS, a Disease, is a preternatural Confusion of the Blood, or Humours of the Eyes. *Blanchard*.

SYNCOPALIS Febris, or the *Swooning Fever*; is that in which the Patient often Swoons and Faints away. *Blanchard*.

SYNCOPATION, a Term in Musick, which is when a Note of one Part ends and breaks off upon the middle of a Note of another Part.

SYNCOPE [συνκοπή, Gr.] in Musick, is the driving a Note, when some shorter Note prefixed at the beginning of the Measure, or Half-measure, is immediately follow'd by two, three, or more Notes of a greater Quantity, before you meet with another short Note equivalent to that which began the driving, to make the Number even. As when an odd *Cratchet* comes before two, three, or more *Minims*, or an odd *Quaver* before two, three, or more *Crotchets*.

SYNCOPE, in Physick, is a sudden Prostration or Swooning, with a very weak, or no Pulse, and a Depravation of Sense and Motion.

SYNCOPE, in *Grammar*, is the taking away a Letter or Letters, out of the middle of a Word: As *Dixti* for *Dixisti*, *Reposum* or *Repositum*.

SYNCRITICA [συνκρητικά, Gr.] are relaxing Medicines.

SYNDESMUS [συνδεσμός Gr.] or *Syndesmous*, the same with a *Ligament*.

SYNDROME [συνδρομή, Gr.] is a Concurrence of several Symptoms in the same Disease.

SYNECDOCHE [συνεκδοχή, Gr.] a Trope in *Rhetorick*, where the Name of the Whole is put for Part; or the Name of the Part for the Whole: As if we should say, *Europe* for *England*, or *England* for *Europe*.

SYNECDOCHE, in *Grammar*, is when the Ablative Case of the Part, or the Adjunct, is changed into the Accusative: As in that of *Virgil*.

*Deiphobum vidi lacerum crudeliter Ora.*

As in this:

*Flores inscripti nomine Regum.*

SYNECHPHONESIS [συνεχφώνησις, Gr.] or *Synizesis*, is a Figure in *Grammar*, whereby two Vowels are contracted into one, as in this Verse of *Virgil*.

*Seu lento fuerint Alvearia vimina texta.*

Where the *ia* in *Alvearia*, are contracted into one Vowel.

SYNEDRENONTA [συνεδρενώω, Gr.] are common Symptoms which accompany Diseases; and

yet neither flow from the Nature of the Disease, nor are necessary Concomitants of it; but do, notwithstanding, signify the Greatness, Continuance, &c. of the Disease.

SYNEUROSIS, is an Articulation of Bones by a Ligament; as the Extremity of the *Ulna*, is joined to the Bones of the *Carpus*.

SYNGULTUS, the *Hiccough*, is a depraved Convulsive Motion of the Stomach, by which it endeavours to expel something that is hurtful, or offensive.

SYNIZESIS. See *Synechphonesis*.

SYNOCHA [συνocha, Gr.] is a continued intermitting Fever; this lasts for many Days with a great Heat, sometimes Putrefactions of the Blood; it is either *Quotidian*, *Tertian*, or *Quartan*. *Blanchard*.

SYNOCHUS, is a continued Fever, without any Intermission, or Abatement of the Heat, which continues for many Days: This is either simple, or accompanied with Putrefaction. *Blanchard*.

SYNOD [σύνoδος, Gr.] a Meeting or Assembly of Ecclesiastical Persons concerning Religion: Of which there are four Kinds.

1. *General*, where Bishops, &c. meet of all Nations.

2. *National*, where those of one Nation only come together.

3. *Provincial*, where they of one only Province meet.

4. *Diocesan*, where those of but one Diocese meet: See *Convocation*, which is the same with *Synod*, only the one is a *Greek*, and the other a *Latin* Word. *Cowel's Interpreter*.

SYNODALS, or *Synodics*, were a pecuniary Rent (commonly two Shillings) paid to the Bishop at the Time of the annual Synod, by every Parochial Priest. For the Bishops used to hold their Diocesan Synods, and to visit all at once; from whence these Synodals are accounted amongst the Bishop's Procurations at this Time.

SYNODALES *Testes*, the Urban and Rural Deans were at first so called, from informing against, and attesting the Disorders, of the Clergy and People in the Episcopal Synod. But when they sunk in their Authority, the *Synodical Witnesses* were a sort of impanelled Jury, consisting of a Priest and two or three Laymen for every Parish. And, at last, two for every Diocese were annually chosen, 'till at last, this Office came to be devolved upon the Church-wardens. Some think our Questmen, who are Assistants to the Church-wardens, were called *Sidesmen*, from hence *quasi Synod-men*.

SYNODALE *Instrumentum*, was the Solemn Oath that these *Synodical Witnesses* took, as now our Church-wardens are Sworn to make their just Presentments.

SYNODICAL *Month*, is the Space of Time (*viz.* 29 Days, 12 Hours, 45 Minutes) contained between the Moon's parting from the Sun at a Conjunction, and returning to him again; during which Time she puts on all her Phases. And her

SYNODICAL *Revolution*, is that Motion whereby her whole System is carried along with the Earth round the Sun.

SYNO-



**SYNONOMY** [*συνώνυμα*, Gr.] is when the same Thing is expressed by several Words that have but one and the same Signification: As if one should say, *He went away, he escaped, he fled.*

**SYNTASIS** [*σύντασις*, Gr.] is a preternatural Distention of the Parts.

**SYNTECTOE** [*συντεκτικός*, Gr.] is a kind of Looseness that proceeds from the melting away of the Substance of the Body by a violent hot Distemper of the solid Parts, such as sometimes happens in the Inflammation of the Bowels, and in a vehement burning Fever, Heetick, or Pestilential; in which a fat Matter, as it were mixt with Oil or Grease, is voided by Stool.

**SYNTENOSIS** [*συντένω*, Gr.] is reckoned by some to be the Union of one Bone to another by a *Tendon*; as the Knee-pan to the Thigh-bone and *Tibia*.

**SYNTERETICK** Medicines [*συντερετικα*, Gr.] are that Part of Physick, which gives Rules for the Preservation of Health.

**SYNTEXIS** [*σύντεξις*, Gr.] is Consumption and Colliquation of the Body, in which first the Flesh is wasted, and afterwards the Substance of the more solid Parts. *Blanchard.*

**SYNTHESIS** [*σύνθεσις*, Gr.] is either the Frame and Structure of the whole Body; or more strictly, the Composure of the Bones. 'Tis also used in *Mathematicks*, in Opposition to the Word *Analysis*; in which Sense it signifies *Composition*, or the

**SYNTHETICAL** Method of *Enquiry*, or *Demonstration* in *Mathematicks*, is when we pursue the Truth chiefly by Reasons drawn from Principles before established, and *Propositions* formerly proved, and proceed by a long regular Chain, 'till we come to the Conclusion: As is done in the Elements of *Euclid*, and in almost all the *Demonstrations* of the Ancients. This is called *Composition*, and is opposed to the Analytical Method, which is called *Resolution*; which see.

**SYNTHESIS** is also used by the *Grammarians*, to signify an Agreement of the Parts of a Sentence as to Sense, but not as to the Words.

**SYNULOTICKS.** See *Cicatrifiantia*.

**SYNYMENSIS**, is taken to be the uniting of Bones together by a *Membrane*, as in Infants; the Bones of the *Sinciput* with the *Os Frontis*.

**SYPHON**, is a Tube, or Pipe of Glass, or Metal, which is usually bent to an Acute Angle; and having one Leg shorter than the other, they are frequently used to draw off Liquors out of one Barrel or Vessel into another, without raising the Lees, or Dregs, and are called *Cranes*. Sometimes Glass Tubes or Pipes, though streight, are called *Syphons*.

For the Cause of the running of Water, or other Liquors, through the *Syphons* or *Cranes*: See *Hydrostaticks*, *Paradox* 10.

**SYRINGE**, is an Instrument which is used in injecting Liquors into Wounds, Ulcers, or any diseased Parts of the Body.

**SYRINGOTOMATA**, are *Chirurgeons Knives*, which they open *Fistulas* with.

**SYRINGOTOMIA** [*of συρίγξ a Syringe, and τέμνω Gr. to cut*] is the Incision of the *Fistula*.

**SYSSARCOSIS** [*συσσάρκωσις*, Gr.] is the Connexion of Bones by Flesh. *Blanchard.*

**SYSTEM** [*σύστημα*, Gr.] in Musick, is the Extent of a certain Number of *Chords*, having its Bounds toward the *Grave* and *Acute*, which hath been differently determined by the different Progress made in Musick, and according to the different Divisions of the *Monochord*.

The *System* of the Ancients was composed of four *Tetrachords*, and one *Supernumerary Chord*, the whole making Fifteen Chords.

**SYSTEM** properly, is a regular orderly Collection, or Composition, of many things together.

Thus the *Solar System*, is the Aggregate Union, or orderly Disposition of all those Planets which move round the Sun as their Centre, in determined Orbits, and never deviate farther from him than their proper and usual Bounds. And a

*System of Philosophy*, is a regular Collection of the Principles and Parts of that Science into one Body, and a treating of them Dogmatically, or in a Scholastical Method; which is called the *Systematical Way*, in Contra-distinction of the *Way of Essay*, wherein the Writer delivers himself more loosely, easily and modestly.

The Learned Dr. *Hook*, did, in the Year 1674, at the end of his Attempt to prove the Motion of the Earth by Observation, promise that he would explain a System of the World, differing in many things from any then known, and yet exactly agreeable to Mechanical Principles. Which System he there says, depends on these three Suppositions, *viz.*

First, That all the Heavenly Bodies have a gravitating or attracting Power towards their own Centers, whereby they attract not only their own Parts, and keep them from flying off from them, but also all other Celestial Bodies within the Sphere of their Activity.

Secondly, That all Bodies put into a direct and simple Motion, will so continue to move forwards in a streight Line, 'till they are by some or other more effectual Power bent or deflected into a Motion, which describes some Curve Line.

Thirdly, That these attractive Powers are so much the more powerful in operating, by how much the nearer the Body wrought upon, is to their own Centers.

All which is abundantly confirmed in Sir *Isaac Newton's Admirable Principia Philosophiæ Mathematicæ*.

**SYSTOLE** [*συστολή*, Gr.] in *Anatomy*, is the Contraction of the Ventricles of the Heart, whereby the Blood is forcibly driven into the great Artery.

**SYSTOLE**, in *Grammar*, is part of the Poetical License, whereby a long Syllable is made short: As in that of *Virgil*:

——— *Tulerunt fastidia Menses.*

**SYSTYLE** [*συσυλος*, Gr.] in *Architecture*, is a Building where the Pillars stand thick, but not altogether so close as in the *Pychnostyle*; the Inter-columniation, or Distance between them, being only two Diameters of the Column.

**SYZYGIE** [*ζυζυγία*, Gr.] in *Astronomy*, is the same with the Conjunction of any two Planets, or Stars, or when they are both referred to the same Point in the Heavens; or when they are referred to the same Degree of the Ecliptick, by a Circle of Longitude passing through them both.

**SYZIGIES**, how to calculate the exact Time of the *True* and *Mean* Syzigies of the Sun and Moon, in order to the Determination of Eclipses, *vid. Whiston*, p. 145.



## T A B

**T**, *In Musick Books*, is sometimes used to mark the Tenor.

**T**, *in Heraldry*, is a kind of Cross Potent, or Furcated, found in the Coat-Armour of the Commanders of the Order of St. Anthony. See *Tau*.

**TABELIÆ**, *in Pharmacy*, is a solid Ele-

**TABLETTES**, *etuary*, or Composition of several Drugs or other Ingredients, made up dry, and formed into little Squares; more commonly called Lozenges.

**TABERDERS**, or *Tabiters*, for so, by Corruption, 'tis now pronounced, are the Batchelor Scholars of the Foundation of *Queen's in Oxon*: They were so called from a short Gown, called *Taberd*, or *Tabert*, in those Days, reaching no lower than their Middle-leg, which these Batchelor Scholars were then obliged to wear.

**TABES**. See *Atrophia*.

**TABES dorsalis**, a Consumption in the spinal Marrow, incident to those who are too much addicted to Venery; they are without a Fever, eat well, and yet waste, or consume away: If you ask one in this Disease an Account of himself, he will tell you, that there seems as if so many Pismires did crawl from his Head down upon his spinal Marrow; when he eases Nature, either by Urine or Stool, there flows thin liquid Matter like a *Semen* plentifully; when he goes to run away, but especially by a steep Place, he grows weak and short-breathed, his Head is heavy, and his Ears tingle; so in process of Time he dies of a Fever called *Lipyrria*, where the External Parts are cold, and the Internal burn at the same time. *Blanchard*.

**TABLATURE**, *in Anatomy*, is a Name given to the Division or Parting of the Skull, as into two Tables.

**TABLATURE**, *in Musick*, is when Letters of the Alphabet or Cyphers, or any other Characters, which are not used in the modern Musick, are used to express the Sounds or Notes of a Composition.

**TABLE**, *in Anatomy*, a *Lamina* of the Cranium, which is composed of two Tables, being double, as if it consisted of two Bones laid one over another.

**TABLE**, *in Architecture*, is a smooth and simple Part of a different Figure; but most commonly in Form of a long Square, or of a Triangle.

*Projecturing Table*, is that which jets out beyond the naked Face of a Wall, Pedestal, or any Part whereof it makes the Ornament: And a

*Raked Table*, is that which is hollow'd in the Square of a Pedestal, or elsewhere.

**TABLE**, *in Perspective*, is a plain Surface, supposed to be transparent, and perpendicular to the Horizon.

**Pythagoras's TABLE**, is a Square, composed of an hundred lesser Squares or Cells, which contain the Products of the several Digits, or simple Numbers multiplied each by other; commonly called the Multiplication Table.

## T A C

*Pythagoras's*, or the Multiplication T A B L E;

|    |    |    |    |    |    |    |    |    |     |
|----|----|----|----|----|----|----|----|----|-----|
| 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10  |
| 2  | 4  | 6  | 8  | 10 | 12 | 14 | 16 | 18 | 20  |
| 3  | 6  | 9  | 12 | 15 | 18 | 21 | 24 | 27 | 30  |
| 4  | 8  | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40  |
| 5  | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50  |
| 6  | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60  |
| 7  | 14 | 21 | 28 | 35 | 42 | 49 | 56 | 63 | 70  |
| 8  | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72 | 80  |
| 9  | 18 | 27 | 36 | 45 | 54 | 63 | 72 | 81 | 90  |
| 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |

This Table is necessary to be learned by Heart, by all those that learn Arithmetick.

*Example*, If it be required to know the Product of 7, multiplied by 9. Look for 7 in the first horizontal Column, beginning with 1. Then look for 9 in the first perpendicular Column, beginning likewise with 1, the Square or Cell where in the perpendicular Column from 7 meets with the horizontal one from 9, contains the Product required, which is 63.

**TABLES**, *in Mathematicks*, are certain Systems of Numbers, calculated for the easy and expeditious performing Astronomical, Geometrical, &c. Operations.

*Astronomical TABLES*, are Computations of the Places, Motions, and other Phænomena of the Planets, both Primary and Secondary.

**TABLES of Sines, Tangents, &c.** that are used in Trigonometrical Operations, are also called *Canons*.

**TABLES of Logarithms, Rhumbs, &c.** used in *Geometry, Navigation, &c.* See *Logarithms, &c.*

*Loxodromick TABLES*, are Tables of Traverses used in Navigation, for the easy and expeditious Solution of Problems in Navigation.

**TABLE**, *in Heraldry*, a Coat or Escutcheon, that contains nothing but the mere Colour of the Field, not being charged with any Bearing, Figure, Moveable, &c.

**TABLETS**, or solid Electuaries, are much the same with *Lozenges*, being made usually of Sugar and Powder, &c. incorporated well together, and given in many Diseases, especially those of the Lungs and Breast.

**TABLING of Fines**, is the making a Table for every County where his Majesty's Writ runs, containing the Contents of every *Fine* passed in any one Term, as the Name of the County, Towns, and Places wherein the Lands or Tenements lie; the Name of the Demandant and Deforçant, and of every Manor named in the *Fine*.

**TABUM**, is a thin sort of Matter that comes from an ill Ulcer. *Blanchard*.

**TACHYGRAPHY** [*ταχυγραφία*, of *ταχυς*, swift and *γραφῆν*, Gr. Writing.] the Art of quick or short Writing.

**TACK**, in a Ship, is a great Rope having a *Wale Knot* at one End, which seized or fastened into the *Clew* of the Sail, is so reeved first through the *Cheffe Trees*, and then is brought through a Hole in the Ship's Side. Its Use is to carry forwards the Clew of the Sail, and to make it stand close by a Wind: And whenever the Sails are thus trimmed, the Main-tack, the Fore-tack, and Mizen-tack are brought



brought close by the Board, and haled as forward on as they can be. The Bowlings also are so on the Weather-side; the Lee-sheets are haled close aft, and the Lee-braces of all the Sails, are likewise braced aft. Hence they say, a Ship *Sails* or *Stands close upon a Tack*, *i. e.* close by the Wind. *Hale aboard the Tacks*; that is, Bring the Tack down close to the Chese-trees. *Ease the Tack*, *i. e.* Slacken it, or let it go, or run out. *Let rise the Tack*, *i. e.* Let it all go out. The Tacks of a Ship are usually belayed to the *Bitts*, or else there is a *Chevil* on purpose to fasten them.

**TACK about**: The Word, when a Ship's Head is to be brought about so as to lie a contrary Way; to do which, First they make her stay (See *Stay*) and when she is stay'd, they say, She is *Pay'd*. The next Word is, *Let Rise and Hale*, that is, Let the *Lee-tack Rise*, and *Hale aft the Sheets*, and so trim all the Sails, by a Wind as they were before; for they cast off that which was before the *Weather-Bowling*, and set up the other taught; and so they do also by all *Sheets*, *Braces* and *Tacks*, which a Ship that is trimmed by a Wind must have.

**TACKLES**, in a Ship, are small Ropes running in three Parts, having at one End a *Pendant* with a Block fastened to them, or else a *Lannier*; and at the other End, is a Block and an Hook to hang any Goods upon, which is to be heaved into the Ship, or out of it.

There are several sorts of these *Tackles*.

1. The *Boat Tackles*, which serve to hoist the Boat in and out, as also for many other Uses: These stand on the Main-mast Shrowds, the other on those of the Fore-mast.

2. The *Tackles* belonging to the Masts, these serve as a kind of Shrowds, to keep the Masts from straining.

3. The *Gunners-Tackles*, with which the Ordnance are hoisted in and out.

4. There is also another called *Wind-Tackle*; which see under that Word.

There is also another kind of *Tackle* which is called a *Burnett*. See *Burnett*.

**TACTICKS** [*τάξις*, *Gr. Order*] the Art of inventing and making the Machines of the Ancients, for throwing of Arrows, Darts, Slings, Stones, Fire-balls, &c. by means of Bows, Slings, and Counterpoises.

**TACTICKS** [*τακτικά*, *Gr.*] is the Art of disposing any Number of Men into a proper Form of Battle: The *Greeks* were very skilful in this part of the Art Military; having Publick Professors of it, who were called *Tactici*, who were to teach and instruct their Youth in this Matter. *Ælian* hath a particular Book on this Subject; and there is a great deal of it in *Arrian*, in his History of *Alex. M.* and in *Mauritius* and *Leo Imperator*.

**TACTILE Quantities**, are such as have a primary Relation to the Sense of Feeling, or to our Touch: As Heat and Cold, &c.

**TÆNIA**, in *Architecture*, is a Member of the *Dorick Capital*, which resembles the Shape of a square Fillet, and serves instead of a *Cymatium*, being fastened, as it were, to a Capital below the *Triglyphs*, whereof it seems to be the Base.

**TAFFEREL**, is the uppermost Part, Frame, or Rail of a Ship abaft over the Poop.

**Dove TAIL**, 2 in *Carpentry*, is one of the *Swallow TAIL*, 5 strongest Manners of Jointing, by inserting a piece of Wood that grows larger towards the End into another Piece, so that it cannot stir out by reason of the Hole in the End is narrower than the lower End in the other, in the Figure of the Tail of a *Dove* or *Swallow*.

**Dragons TAIL**, in *Astronomy*, the descending Node of a Planet, which is represented by this Character ♄, *Cauda Draconis L.*

**TAIL of a Comet**, is when its Rays are shot behind that part from whence it appears to move; and on the contrary, when a Comet darts its Rays forwards, or towards that part of the Heavens to which its proper Motion seems to be carrying him, those Rays are called its Beard.

**TAIL of the Trenches**, in *Fortification*, is the first Work that is made by the Besiegers at the opening of the Trenches, as the Head of the Attack is carried on towards the Place.

**TAIL**, in *Common Law*, signifies two several Things both grounded upon one Reason. First, it is to be used for the *Fee*, which is opposite to *Fee-simple*, by Reason it is so minced or parted, as it were, that it is not in the Owner's free Power to dispose, but is by the first Giver cut or divided from all others, and tied to the Issue of the Donee: And this Limitation of *Tail*, is either *General*, or *Special*.

*Tail General*, is that whereby Lands or Tenements are limited to a Man, and to the Heirs of his Body begotten; and it is so called, how many Wives soever the Tenant holding by this Title shall have one after another in Lawful Marriage; his Issue by them all, have a Possibility to inherit one after another.

*Tail Special*, is when Lands or Tenements limited to a Man and his Wife, and the Heirs of their two Bodies begotten; and hath this Term of *Special*, because if the Man bury his Wife before Issue, and take another, the Issue by his second Wife cannot inherit the Land, &c. Also, if the Land be given to a Man and his Wife, and their Son R. for ever; this is *Tail Special*.

**TAILLE Douce**, a Term in Painting, signifying, as Mr. *Evelyn* in *Chalcography* tells us, the Art of Sculpture or Chalcography itself. In *French* it signifies *sweetly or tenderly cut*; and this, whether done with the *Burin* (or Graver) or with *Aquafortis*, which we call *Etching*. He saith, the *Italians* call it *Intaglia* or *Stamp*, without any Epithet or Adjunct; and also *Bolino*, which he takes to be the more ancient and warrantable, as implying the use of the *Point* and *Needle*, and of *Etching* with *Aquafortis*; which is sometimes so happily performed, as scarce to be discerned from the finest Strokes of the *Bolino*, or Graver itself.

**TAIL after Possibility of Issue Extinct**, is where Land is given to a Man and his Wife, and to the Heirs of their two Bodies, the one over-lives the other without Issue between them begotten; he shall hold the Land for Term of his own Life, as Tenants in *Tail after Possibility of the Issue Extinct*; and notwithstanding that he do waste, he shall never be Impeached of it: And if he Alien, he in the Reversion shall not have a Writ of Entry in *consimili Casu*, but he may enter, and his Entry is lawful.

**TAILLOIR**. See *Abacus*.



**TAINT**, in Law, signifies Substantively, either a Conviction; or Adjectively, a Person Convicted of Felony or Treason, &c. See *Attaint*.

**TAKE and leave**, they say at Sea, when a Ship fails so well that she can come up with another, or out-fail her when she pleases; that *she can Take and Leave upon her*, whenever she will.

**TALES**, in Law, is taken for a supply of Men, impannelled upon a Jury or Inquest, and not appearing, or at their Appearance challenged by either Party as not indifferent; in which Case the Judge, upon Motion, grants a Supply to be made by the Sheriff of one or more such there present; and hereupon the very Act of supplying is called a *Tales de Circumstantibus*: But he that hath had one *Tales* either upon Default or Challenge, may not have another to contain so many as the former: For the first *Tales* must be under the principal Pannel, except in a Cause of Appeal, and so every *Tales* less than other, until the Number be made up of Men present in Court, and such as are without Exception; yet this general Rule is not without some Exceptions, as appears by *Stamford Pl. Cor. Lib. 3. Cap. 5*. These commonly called *Tales*, may in some sort, and indeed are called *Meliores*, viz. when the whole Jury is challenged.

**TALLY the Sheats**, is a Word of Command at Sea, when the Sheats of the Main-sail or Fore-sail are to be haled aft. See *Sheets*.

**TALON**, a small Member in Architecture, composed of a square Fillet, and a streight *Cymatium*. It differs from the *Astragal*, which is a round Member, whereas the *Talon* consists of two Portions of a Circle, one without, and the other within; and when the Concave Part is uppermost, it is called *Reversed Talon*.

**TALLAGE**, was formerly a certain Rate or Proportion, according to which Barons and Knights were taxed by the King, and inferior Tenants by their Lords. And this latter *Tallage* of the Customary Tenants was sometimes fixed and certain, and sometimes at the arbitrary Pleasure of the Lord; and it was also sometimes compounded for.

**TALPA**, is a Tumor, so called, because that as a Mole (in *Latin Talpa*) creeps under Ground; so this feeds upon the Skull under the Skin: It may be referred to the Species of *Athermas*; which see. *Blanchard*.

**TALUS**, the same with *Astragalus*. See it described under the Word *Tarsus*.

**TALUS**, or *Talut*, properly signifies any Thing that goes sloping, as the *Talus* of a Wall in Masonry, when its thickness is diminished by Degrees as it rises in height. But in *Fortification*, the *Talus* of a *Bastion* or *Rampart*, is the Slope allowed to such a Work, whether it be of Earth or Stone, the better to support its Weight.

**TALUS Exterior**, of a Work, is its Steepness on the Sides of the Field; and is always made as little as possible, to prevent the Enemies *Scalado*, unless the Earth be bad; then it is absolutely necessary to allow a considerable *Talus* for its *Parapet*.

**TALUS Interior**, of a Work, is its Steepness on the inside towards the Place.

**TALUS Superior**, in Fortification, is the Slope on the top of the *Parapet*; for the top of the *Parapet* is made sloping, that the Soldiers may de-

send the Covert-way with small Shot, which they could not do if it were level.

**TAMBOUR**, in *Architecture*, is applied differently.

1. To the *Corinthian* and *Composit* Capitals, as bearing some resemblance to a Drum, which the *French* call *Tambour*.

2. To a round Stone, or of Stones, several of which form a Section of the Shaft of a Column, that is not so high as a Diameter.

3. To a Listel of Timber-work, covered with a Cieling, within side the Porches of certain Churches; both to prevent the View of Persons passing by, and to keep off the Wind, &c. by means of Folding Doors, &c.

**TAMPKIN**, *Tampion*, or *Tampin*, at Sea, is a round piece of Wood fitted to the Muzzle of a Great Gun, which serves to stop it so, that no Water or Rain may get in to wet the Powder.

**TANGENT**; a Plane is said to be a Tangent to a Cone, when 'tis coincident with two Lines, one of which is drawn on the Surface of the Cone, and through its Vertex, and the other a Tangent to the Circle of the Base, meeting the former Line in the Point of Contact.

**TANGENT Line**, how the Line of Tangents and half Tangents are made, you'll find under *Scales*; and their Uses in *Projecting* and *Measuring* the Parts of *Right Circles* in Spherical Projection, you have under Spherick Projection. And the Use of the Line of artificial Tangents, in concert with the Line of Sines and Numbers, you have in Plain Trigonometry, &c. But there are some other Uses of the Lines of Tangents and half Tangents in *Dialling*, &c. Sometimes on the Edge of *Gunter's Sector* you have *Tangent Line*, in whose End a Pin or Gnomon, equal to Radius, is normally placed; and by that means the Sun's Altitude may be had, by holding the Sector erect, and the Pin parallel to the Horizon; for then the Shadow of the Gnomon, when turned to the Sun, will, in the Divisions of the Tangent shew the Degree of the Sun's height.

This Tangent Line is used also to draw the Hour-Lines on the Planes of Dials; and is commonly known and shewn in almost all Books of *Dialling*.

On the Cross-staff there are also Lines of Tangents drawn; one usually of 36 Deg. 3 Min. and another of 49 Deg. 6 Min. which, because their middle Points are at 20 and 30, are, by Mr. *Gunter*, called the Tangents of 20 and 30. These Tangents are used in taking of Angles, the Altitude of the Sun or Stars, &c. as you will find under *Cross-staff*.

Dr. *Wallis* gives an Abstract of his two Methods of drawing Tangents to Curves, in *Philosophical Transactions*, N<sup>o</sup> 81. which are taken from his *Conick Sections*, and other Parts of his Mathematical Works. And Dr. *Barrow*, in his fourth Geometrical Lecture, p. 40. gives a general Method of determining the Tangents to all *Cycloids*, and all other Curves described, or generated after the manner of a *Cycloid*. In Lect. 9, 10. he shews how to determine Tangents to all manner of *Spiral Curves*, and to many Curves of other kinds. In

*Philosophical*



*Philosophical Transactions*, N<sup>o</sup> 284. you have a Method of Tangents, by Mr. *H. Ditton*, taken from the Theory of *Maxima* and *Minima*, which is very simple and universal.

TANGENT, of a Parabola (or other Conick Section, or Geometrical Curve) is a Right Line drawn, cutting the Axe produced, and touching the Section in one Point without cutting it.

In *Philosophical Transactions*, N<sup>o</sup>. 90. there is an easy Method of *Slufius*, to draw Tangents to all Geometrical Curves without any Labour of Calculation: The Demonstration of which you have afterwards, *Hunt's* 95, communicated by the same Author, and is contained in these three *Lemmata*.

1. The Difference between any two Dignities, or Powers of the same Dimensions or Degrees, divided by the Difference between the Roots of those Powers, gives several Parts or Members of the next inferior Powers, which may be formed from those two Roots, as from a Binomial, thus.

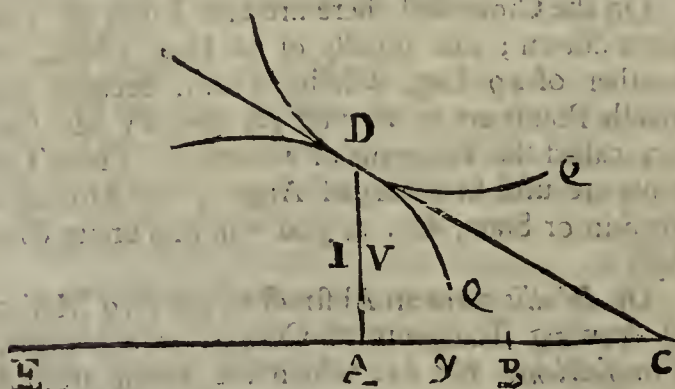
$$\frac{xxx - yyy}{x - y} = xx + xy + yy.$$

2. There are always so many several Members in any Degree or Power raised from a *Binomial*, as are the Units in the *Exponent* of the Power next above it. Thus in the Square of a *Binomial*, there are three Members; in the Cube, there are four, &c.

3. If any Quantity divide two others, whose Ratio is given, the Quotients will be also reciprocally in the same given Ratio; or the Quotients of any two Numbers, or Quantity, divided by one and the same Quantity, are as the Dividends.

This premised, Let there be any Curve, as *DQ*, whose Points are all referrable to any Right Line given, as *EAB*, whether that Right Line be the Diameter, or not; or whether there be more given Right Lines than one, if their Powers do but come into the Equation, 'tis enough.

And in all his Equations he puts *V* always for the Line *DA*, *y* for *BA*; and for *EB*, and the other given Lines, he puts *bd*, &c. *i. e.* always, Consonants.



Then supposing *DC* to be drawn touching the Curve in *D*, and meeting with *EB*, produced in *C*, he always calls the sought Line *CA*, by the Name of *a*.

To find which he gives this general Method.

#### R U L E I.

He rejects out of the Equation all Members which have not either *V* or *y* with them; then he

puts all those that have *y* on one side, and all those which have *V* on the other, with their Signs + or -. And the latter, for Distinction and Ease sake, he calls the *Right*, the former the *Left Side*.

#### R U L E II.

On the Right Side, let there be prefix'd to each Member, the Exponent of the Power which *u* hath there: Or, which is all one, let that *Exponent* be multiplied into all the Members.

#### R U L E III.

Let the same be done also on the Left Side, multiplying each Member there by the *Exponent* of the Power of *y*.

Adding this moreover, that one *y* must (in each Member) be always changed into *a*.

This done, I say, that the Equation thus reformed, will shew the Method of drawing the required Tangent to the Point *D*; and when that is given, as also *y*, *u*, and the other Quantities expressed by Consonants, *a* cannot be unknown.

Let there be this Equation  $by - yy = VV$ , in which *EB* is *b*, *BA* = *y*, *DA* = *V*; and let *a*, or *AC* be required to find the Point *C*, from whence *CD* being drawn, shall be a true Tangent to that Curve *QD*, in *D*.

In this Example nothing is to be ejected out of the Equation, because *y* or *V*, are in each Member: 'Tis also so disposed as required by *Rule 1*. To each Part therefore there must be prefix'd the Exponent of the Powers of *y* and *V*, as in *Rule 2*; And on the Left Side, let one *y* be changed into *a*: And then the Equation will be in this Form,  $ba - 2ya = 2VV$ , which Equation reduced, gives easily the Value of  $a = \frac{2VV}{b - 2y} = AC$ . And so the Point *C* is found, from whence the Tangent *DC* may be drawn.

To determine which way the Tangent is to be drawn, whether towards *B* or *E*, he directs to consider the Numerator and Denominator of the Fraction, which at last is found equal to *a*. For,

1. If in both Parts of the Fraction, either all the Signs are Affirmative, or if the Affirmative ones are more in Number, then the Tangent is to run towards *B*.

2. If the Affirmative Quantities are greater than the Negative in the Numerator, but equal to them in the Denominator, the Right Line drawn through *D*, and touching the Curve in that Point, will be parallel to *AB*: For in this Case, *a* is of an infinite Length.

3. If in both Parts of the Fraction, the Affirmative Quantities are less than the Negative, changing all the Signs, the Tangent must be drawn now also towards *B*: For this Case, after the Change, comes to be the same with the first.

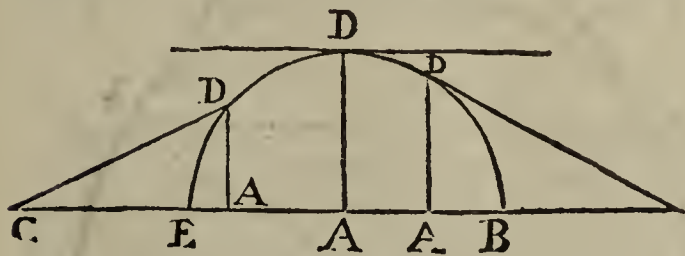
4. If the Affirmative Quantities are greater than the Negative in the Denominator, but in the Numerator are less, or *vice versa*; then changing the Signs



Signs in that Part of the Fraction where they are less, the Tangent must be drawn a contrary way ; *i. e.* A C must be taken towards E.

5. But whenever the Affirmative and Negative Quantities are equal in the *Numerator*, let them be how they will in the *Denominator*, *a* will vanish into nothing : And consequently either A D itself is the Tangent, or else E A ; or at least, a Line parallel to E A, as will easily be found by the Data.

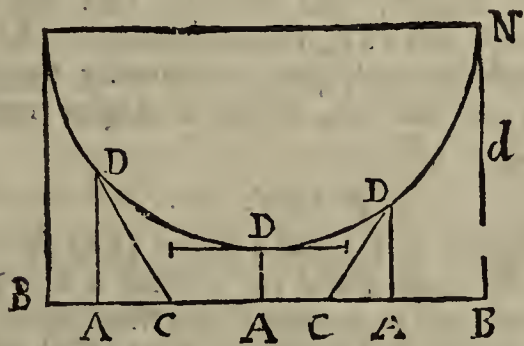
This he gives plain Examples of, in Reference to the Circle, thus.



Let there be a Semi-circle, whose Diameter is EB, in which there is given any Point ; as D, D, D, &c. from which the Perpendicular D A, is let fall to the Diameter.

Let  $DA = V$ ,  $BA = y$ ,  $BE = b$  : Then the Equator will be  $by - yy = VV$ , and drawing the Tangent DC, AC or  $a = \frac{2VV}{b - 2y}$ .

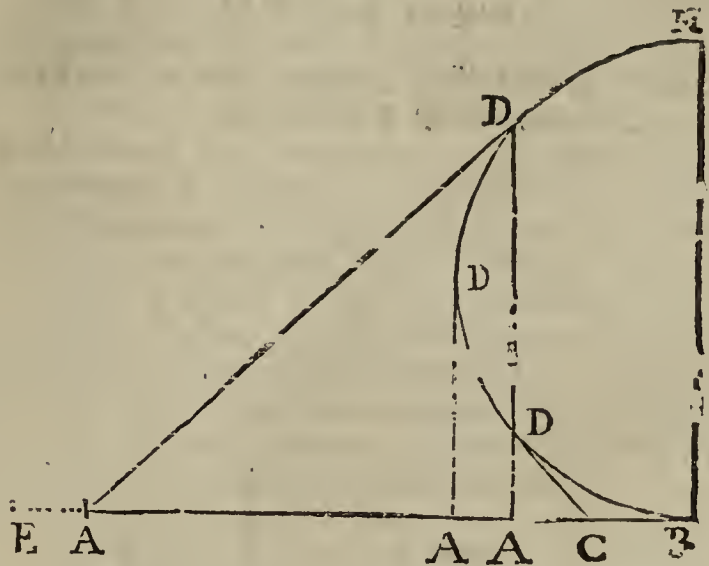
Now if *b* be greater than  $2y$ , the Tangent must be drawn towards B ; if less, towards E ; if it be equal to it, it will be parallel to EB, as was said in the 1st, 2d, and 4th Rules.



Let there be another Semi-circle inverted ; as, N D D ; the Points of whose Periphery are referred to the Right Line B B, parallel and = to the Diameter.

Let NB be called *d* ; and all things else, as before ; then the Equation will be  $by - yy = dd + VV - 2dV$  ; which being managed according to his Rules, you have  $a = \frac{2VV - 2dV}{b - 2y}$ .

Now since *V* here is supposed to be always less than *d* ; if *b* be greater than  $2y$ , then the Tangent must be drawn towards E ; if *equal*, it will be parallel to B B ; if *less*, changing all the Signs, the Tangent must be drawn towards B, as by Rule 4, 5, and 3. But there could be no Tangent drawn, or at least, EB would be it, if NB had been taken equal to the Diameter.



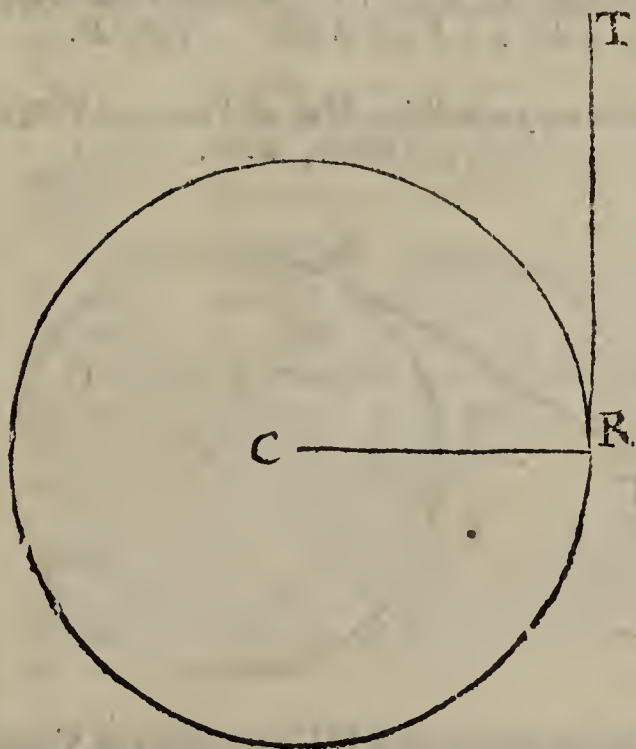
Let there be another Semi-circle, whose Diameter NB, is perpendicular to EB, and to which its Points are supposed to be referred.

Let NB be called *b*, and all things else as above ; the Equation will be  $yy = bV - VV$ , and  $a = \frac{bV - 2VV}{2y}$ .

If now *b* be greater than  $2V$ , the Tangent must be drawn towards B ; if *less*, towards E ; if *equal*, DA will be the Tangent ; as by Rule 1, 4, and 5, appears.

N. B. In the *Acta Eruditorum* for December, 1682. there is an universal Method for drawing Tangents to all Curves, which is an Improvement of this.

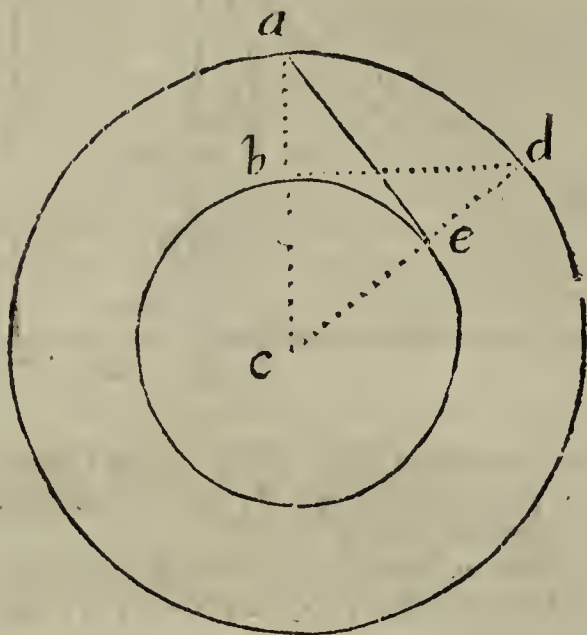
**TANGENT** of a Circle in Geometry, is a Right Line, as TR drawn without the Circle, perpendicular to some Radius, as CR, and which touches the Circle but in one Point.





## P R O B L E M

To draw from a Point given, as  $a$ , the true Tangent  $a e$ , to any given Circle, as  $c b e$ .

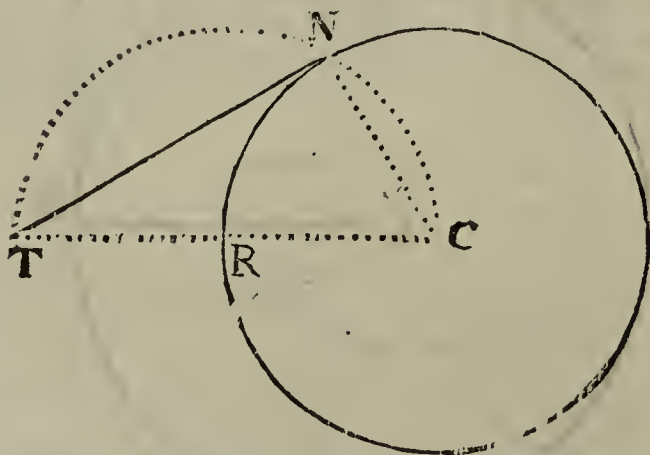


Join the Point  $a$  and the Centre of the Circle, by drawing the Line  $a c$ . Then with the Radius  $a c$  on  $c$ , describe another Circle; erect a Perpendicular on  $b$ , which shall cut the latter Circle in  $d$ ; draw  $d e$ , cutting the former Circle in  $e$ ; then  $a e$  being drawn, is the Tangent required.

## Demonstration.

The Line  $e a$  is a true Tangent, because perpendicular to the Radius  $c e$ , and 'tis perpendicular to  $a e$ , because  $c e a$  is a Right Angle; and  $c b a$  is a Right Angle, because 'tis equal to  $c b d$  (which was made so by Construction) and 'tis equal to  $c b d$ , because the Triangle  $c b d$ , is equal to the Triangle  $a o c$ , as having two Sides and one Angle equal: Wherefore the Angle  $c e a$ , is equal to the Angle  $c b d$ , which is a Right Angle. Q. E. D.

Another very expeditious Way of drawing a Tangent to a Circle, is this.

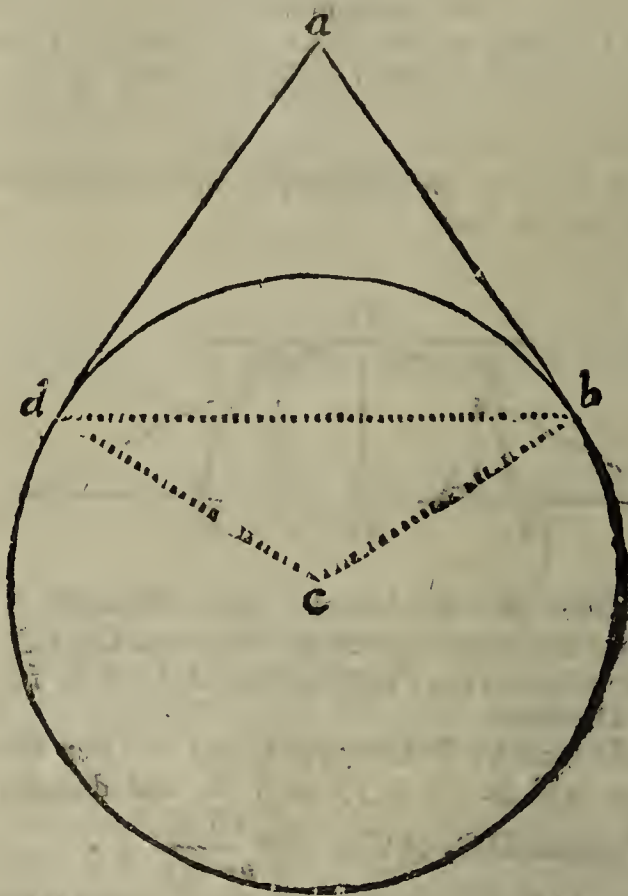


Let the Circle be  $R N C$ , the Point of Contact  $N$ ; transfer the Radius  $N C$ , any where from  $N$ , downwards into the Position  $R C$ , so that  $R N$  be equal to  $R C$ ; then with  $R C$  on the Centre  $R$ , strike a Semi-circle, and a Ruler laid from  $C$  thro'  $R$ , will find the Point  $T$ ; from whence  $T N$  being drawn, will be a true Tangent, because the Angle  $T N C$  being in a Semi-circle, is a Right one.

## P R O P O S I T I O N I.

If two Tangents be drawn to any Circle from a Point ( $a$ ) without, these Tangents shall always be equal.

I say,  $a d = a b$ .

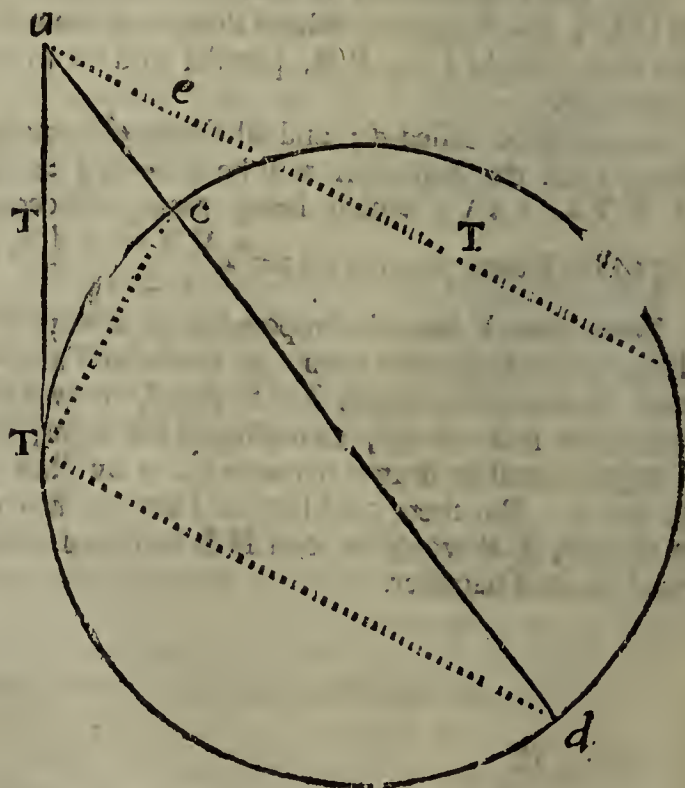


## Demonstration.

The Triangle  $d b c$  being an Isosceles, the Angle  $c b d =$  Angle  $c d b$ ; the Right Angles  $a d c$ , and  $a b c$  are also equal: Wherefore if from these right and equal Angles, you severally take the equal Angles  $c b d$ , and  $c d b$ , the Remainders  $a b d$ , and  $a d b$ , must be equal, and consequently the opposite Sides  $a d$ , and  $a b$ , to those Angles must be equal. Q. E. D.

## P R O P. II.

If a Tangent ( $a T$ ) and a Secant ( $a d$ ) be drawn from the same Point ( $a$ ) without a Circle; the Tangent will be a mean Proportional between the whole Secant ( $a T$ ) and the Part ( $a c$ ) without the Circle.



Or,



Or, as *Euclid* expresses it.

*The Square of the Tangent (a T) is equal to the Rectangle made by the whole Secant (a d) and the external Part (a c) That is, a T q = a d x a c.*

Draw  $c T$ , and  $T d$ .

#### Demonstration.

Then will the Triangles  $T a c$ , and  $T a d$ , be similar; for the Angle  $a$  is common to both, and  $a T c = d$ , because made by a Tangent  $a T$ , and a Secant  $c T$ . Therefore  $c a : a T :: a T : a d$ . That is,  $a T$  is a mean Proportional between  $c a$ , and  $a d$ ; and also  $\square a T = \square d a e$ . Q. E. D.

#### COROLLARY I.

Hence may a Line be easily divided, according to extreme and mean Proportion; if from a Secantwise to the Circle, you draw a Line so as that the Part within be equal in Length to the Tangent. Thus, Let the prick'd Line be so drawn from  $a$ , that the Part within the Circle be equal to  $T$ . Then 'tis plain, if the Part without be called  $e$ , by this Proposition,

$$e e + e T = T T.$$

**TANGIBLE** Bodies, are such as are discoverable and sensible by our Feeling or Touch.

**TAPER-BORED**, in *Gunnery*, a Piece of Ordnance is said to be Taper-bored, when it is wider at the Mouth than towards the Breech.

**TARASS**, } in *Masonry*, a sort of Plaister,  
**TERRASS**, } or strong Mortar, chiefly used in lining Basons, Cisterns, and other Reservoirs of Water.

**TARAXIS** [*ταράξις* of *ταράσσω*, Gr.] is a Perturbation of the Humours of the Eye, the Stomach, or the Entrails. *Blanchard*.

**TARE** and *Tret*; *Tare* is the Weight of Box, Straw, Cloth, &c. wherein Goods are packed.

The other, *viz.* *Tret*, is a Consideration allowed in the Weight for Waste, in emptying and reselling the Goods.

**TARIF**, in *Arithmetick*, is either a small Table of the Divisor multiplied by the 9 Digits to expedite Multiplication; or else a Proportional Table contrived for the expediting a Question in the Rule of Fellowship, when the Stocks, Losses and Gains are very numerous.

**TAR-PAWLING**, in a *Ship*, is a piece of Canvas well Tarr'd over, to lay on any Place to keep off Rain.

**TARSUS**, is a Cartilaginous Extremity of the Eye-lids, whence the Hairs spring, called *Cilium*. *Blanchard*.

**TARSUS**, is the Space between the lower End of the two Focils, and the Beginning of the Five long Bones which sustain, and are articulated with the Toes: Some call this the *Instep*, but that is the *Metatarsus* rather.

The *Tarsus* hath seven Bones, which differ from one another very much in both Shape and Bigness.

The first, is the *Talus*, called also *Astragalus* the Ankle or Huckle-bone: This Bone has above a con-

vex Head with a shallow *Sinus* in it, articulating with the *Tibia*: By the Process of which *Tibia*, which makes the inner Ankle, it is hedg'd in, as it were, on the inside, as it is by that of the *Fibula* on the outer; before, it hath a long Neck, on which grows a round Head, that enters into the *Sinus* of the *Os Naviculare*; on which Jointing the Foot is moved side-ways: Its inner side is rough, and above hath a Transverse *Sinus* to receive the Ligament of the *Tibia*, and below there is a descending *Sinus*, by which the Tendons of the Muscles of the Foot pass: At the bottom of all there is a *Sinus* behind, and Protuberance before, by which it is articulated with the *Os Calcis* by a *Ginglymus*.

The second Bone of the *Tarsus*, is the *Os Calcis*, or *Calcaneum*, which see.

The third, is the *Os Scaphoides*, *Naviculare*, or *Cymbiforme*, which see.

The remaining Four stand all in one Rank, being less than the three former; and the first, articulates with the *Os Calcis*; the other three, with the *Os Naviculare*: There is no Cartilage between them, but they are knit together on the outside like a Cartilaginous Ligament. The first of these is called *Cubiforme*, having six almost equal sides, is the greatest of these Four, and is seated on the outside of the Foot. See *Cubiforme*. The other Three are called *Offa Cuneiformia*, from their Wedge-like Shape; for above they are thick, and below they are thin. See that *Word*.

**TARTANE**, is a small Vessel, much used in the *Mediterranean*, with but one Mast, and the three-cornered Sail, like a Galley; they fish with them on the Coasts of *Spain*.

**TARTAR Emetick**. See *Emetick Tartar*.

**TARTAR Soluble**. See *Soluble Tartar*.

**TARTAR Vitriolate**, is made by pouring Spirit of Vitriol on Oil of Tartar, *per Deliquium*, by little and little; and when the Effervescence is over, placing the Glass in the Sand, and evaporating the Moisture with a small Heat, that a very white Salt may remain at the Bottom. This is the Tartar Vitriolate; 'tis a good Apertive, and a little Purgative Medicine, and works also by Urine: Dose from 10 to 30 Grains.

**TASSELS**, in a Building, are those Pieces of Boards that lie under the ends of the Mantletrees.

**TASTE**, is probably caused by the Salts that are in Bodies; which, according to their various Configurations, affect the Tongue as variously; and tickling, or otherwise moving the Extremities of these small Nerves, which terminate in the *Papillæ* of the Tongue, communicate a pleasant or ungrateful Sensation to the Brain.

The Organ of Taste seems to be neither the Membranes, nor the Nerves of the Tongue (properly speaking) nor the *Glandulæ Amygdalinæ*; but those little Eminences, or *Papillæ*, which are found on the Tongues of all Animals.

For First, those *Papillæ* are found plentifully from the Root of the Tongue to the Tip; but none from thence to the String; or at least but very few.

Secondly, Any Salt, or strong tasted Object, being placed on the Parts void of those *Papillæ*, effects not the Taste at all.

Thirdly,



Thirdly, In those *Papillæ*, in the Tongues of Live Animals, may (by a Microscope) be discerned many small Holes supplied at the Bottom by small Nerves, which communicate the *Sensation* to the Brain.

That various Tastes may be Mechanically produced, and that Sapours do depend on the Shape, Size, Motion, &c., of the small Saporifick Particles of the Saporous Body;

The Honourable Mr. *Boyle*, hath abundantly made out by Experiments and Observations about the Mechanical Production of Tastes.

Dr. *Grew*, in his Lecture about the Diversities of Tastes, read before the *Royal Society*, March 25th, 1675. distinguishes Tastes into Simple and Compound.

By the former of which, he understands such as are Simple or Single Modes of Tastes, altho' mingled with others in the same; thus, the Taste of a Pepin, is *Acid-dulcis*; of Rhubarb, *Amara-stringent*, and therefore compounded in both; but yet in the Pepin the Acid is one Simple Taste, and the Sweet another, as distinct as the Bitter and Astringent are in the Rhubarb.

Two Faults, saith the Doctor, have here been committed: The *Defective Enumeration of Simple Tastes*, and *Reckoning them Indistinctly among such as are compounded*.

*Simple Tastes* (of which usually are reckoned not above six or seven Sorts) are, at least, *sixteen*.

1. *Bitter*, as in Wormwood, whose Contrary is,
2. *Sweet*, as in Sugar.
3. *Sowre*, as in Vinegar; whose Contrary is,
4. *Salt*.
5. *Hot*, as in Cloves; to which is opposite,
6. *Cold*, as in *Sal Prunellæ*; for we may as properly say, a *Cold Taste*, as an *Hot one*; since there are some Bodies which do manifestly impress the Sense of Cold upon the Tongue, though not to the Touch.
7. *Aromatick*; to which is contrary,
8. *Nauseous*, or Malignant.
9. He thinks also, that Tastes may be distinguished into such as are *Soft*, which are either *Vapid*, as in Water, Starch, Whites of Eggs, &c. or *Unctuous*, as in Oils, Fat, &c.
10. Or such as are *Hard*.

Of which he reckons four Kinds. As,

1. *Penetrant*, which worketh itself into the Tongue, without any Pungency; as is found in the Root and Leaves of Wild Cucumber.
2. *Stupefacient*, as in the Root of black Hellebore; which being chewed, and for some Time retained upon the Tongue, affects the Tongue with a Numbness, or Paralytick Stupor.
11. 3. *Astringent*, as in Galls. And,
4. *Pungent*, as in Spirit of *Sal Armoniack*, which two Tastes he makes contrary to the *Unctuous*; as *Penetrant*, and *Stupefacient*, are contrary to the *Vapid one*.

The compounded Tastes are very numerous, but we have Words to express but six of them. As,

1. *Austere*, which is *Astringent* and *Bitter*; as in the green and soft Stones of Grapes.

2. *Acerb*, properly so called, is *Astringent* and *Acid*; as in the Juice of unripe Grapes.

3. *Acrid*, which is Pungent and Hot.

4. *Muriatick*, is Salt and Pungent; as in common Salt.

5. *Lixivious*, which is Saltness joined with some Pungency and Heat.

6. *Nitrous*, which is Saltness, joined with Pungency and Cold.

TAUGHT, in the Sea Language, is the same as setting a Rope stiff, or fast. They say, *Sett Taught the Shrouds*, to Stays, or any other Ropes which are too slack, and loose.

TAUNT, when the Masts of a Ship are too tall for her, they say she is *Taunt-masted*, or that her Masts are very *Taunt*.

TAURUS, is the second Sign of the *Zodiack*.

TAUTOLOGY [*ταυτολογία*, Gr.] is a vain Repetition of Words, which serves only to lengthen out Discourse, and tire the Reader.

*Tautological Echos*, are such as repeat the same Sound or Syllable many times; whereas those which repeat many Syllables or Words distinctly, are called *Poly syllabical Echos*.



T A W: The Heralds have an Ordinary which they reckon among the Crosses, called by this Name, and of this Figure.

TAXERS, are two Officers chosen in *Cambridge*, to look after the true Gage of all Weights and Measures.

TAXIS [*τάξις*, Gr. *Order or Disposition*] a Term used by *Vitruvius*, for what is now called Ordinance; that which gives every part of a Building its just Dimensions, with respect to its Uses.

TAYL, in *Heraldry*, is used particularly for the Tail of an Hart; those of other Animals, having peculiar and distinct Names.

TECHNICAL [*of τεχνική*, Gr. *Art*.] is sometimes the same with *Artificial*, and expresses whatever relates to the Arts and Sciences, as the *Term*, *Rules*, &c. So that the Terms of Art are commonly called *Technical Words*.

TEETH. The Teeth are called in *Latin*, *Dentes*, *quasi Edentes*, from their Office of *eating*, or *chewing*. They are fixed in their *Alveoli*, three manner of Ways.

The first and chief is by their Articulation with the Jaw-bones, by *Gomphosis*.

The second is, by the Nerve which is inserted into their Root by *Synneurosis*.

And the last is, by the Gums, which cleave to the outside of their Roots by *Syffarcosis*.

Their *Substance* is the hardest of all other Bones, but more especially that Part of them that stands out naked above the Gums. This Part, Dr. *Havers* thinks ought to be esteemed rather stony than bony, and yet not the whole of it neither, but only the Outside, or *Cortex*, which, like a Shell, covers the Bony; which being broken off, or decayed, the Bony quickly rots, and moulders away: Upon which account it is, that when the Gums are eaten away, so that some part of the Tooth, which is not defended with this stony *Cortex*, is laid bare, is



it is eroded; when that Part that naturally stands out of the Gums, and is by such a solid Substance secured, suffers no such Injury, the stony Part is not covered with any *Periosteum*, but that Part which is within the Sockets of the Jaw-bones, is invested with a thin Membrane; which, he says, is not the true *Periosteum* (though that invests the Socket wherein they stand) but is propagated from that Membrane that covers the Gums, and is common to the whole Mouth, which does not terminate with the Gums, but when it comes to their extreme Edge, turns in, and is reflected between the other side of the Gum, and the Tooth, descending into the *Alveolus*, or Socket, and adhering on one side, immediately to those Parts of the Teeth which lie within; and on the other, to the hard fleshy Substance of the Gums, which with this is communicated to the Roots of some Teeth (especially in the upper Jaw) to fasten them more firmly in their Sockets; and where none of this hard Flesh intervenes, it coalesces, as it were, into one Membrane with the *Periosteum*, that covers the inside of the Socket. By this Membrane, and the Nerve inserted into the Root of every Tooth, these lower Parts of the Teeth become exquisitely sensible.

The Grinders have a manifest Cavity within (but the *Incisores* and *Canini* but an obscure one) whereunto by the very small Holes of their Roots, they each receive a Capillary Artery from the *Carotides*, a Vein from the Jugulars, and a Twig of a Nerve from the fifth Pair. The Vein, Artery, and Nerve are united together, and clad with a common Membrane when they enter the Jaw, within which they have a proper Channel to run along in, under the Roots of the Teeth, sending Twigs to each, as they pass under them.

The Rudiments, or Principles of the Teeth, are bred with the other Parts of the Womb, but lie hid for some Months within the Jaws and Gums. These Principles are partly Bony, and partly Mucous, and both Parts are at first included in a Membranous, and somewhat Mucous *Folliculus*, or Case, which in Process of Time they break through (some sooner, other later) their Bony Part ascending upwards out of the Gums; and their Mucous Part (hardening by Degrees) descending downwards into the Jaw so far as there is space for it; the *Folliculus* itself turning to a kind of Cement, whereby the Tooth is fastened to the sides of the *Alveolus*.

At what time, and in what order, they break forth out of the *Alveoli*, is known to every Nurse: Omitting therefore to speak of that, I shall only Note, That the Teeth alone, of all the Bones in the Body, continue to grow so long as a Man lives (and they continue in his Head) for else they would be soon worn to the Stumps by their daily Use; and we see that when a Tooth is lost out of either Jaw (in the oldest People) that which is opposite to it in the other Jaw, will commonly grow longer than the rest, having none to grind against: Though it must be confessed, that the seeming length of old Peoples Teeth, is more owing to the falling away of their Gums, than the growth of their Teeth.

When Children come to be seven or eight Years old, they change several of their Teeth; but very rarely, if ever, all. The *Incisores*, or Fore teeth; the *Canine*, or Eye-teeth, and the foremost Double-teeth most change; but the rest of the Double-

teeth very few. Now concerning this changing of the Teeth, we must know, that the old ones do not come out by their Roots, but their upper Part only drops off, their Root remaining still in the Socket of the Jaw; which (being like Seed for the new ones) by degrees grows up above the Gums, to supply the Place of that which is fallen off. Commonly about the twentieth Year (or upwards) there spring out two Double-teeth behind the rest, which 'till then, had lain hid in their Sockets. These are called *Genuine Teeth*, or *Dentes Sapientiae*, because Men are then come to Years of Discretion.

As for the Number of them, commonly there are found sixteen in each Jaw; if there fall out any Difference in Number, as to individual Persons, it generally falleth out in the *Molares*.

There are three Ranks, or sorts of Teeth.

Those of the *first* Rank (for the foremost) are called *Incisores*, Cutters. Most commonly four are found in each Jaw; they have but one Root, or Fang; and so easily fall, or are pulled out. These first make way out of the Gums in Children, because the Tops of them are sharpest.

Those of the *second* Rank, are called *Canini*, or Dog-teeth, from their length, hardness, and sharpness above the rest: In each Jaw there are two; at each side of the Cutters, one. They are otherwise called *Eye-teeth*, either from an Opinion that their Roots (*viz.* of the upper) reach as far as the Eyes, or that the same Nerve that moves the Eye, sends a Twig to these Teeth; neither of which Concoits are true: The Roots of these are single, as those of the *Incisores*, but they are both sometimes crooked; and if such People in whom they are so, chance to have one of them drawn, they can hardly be pulled out, without breaking off a Piece of the *Alveolus*, in which they are fix'd.

Those of the *third* Rank, are called *Molares*, Grinders, because, like Mill-stones, they grind the Meat. Most commonly they are twenty in Number, five in each side of both Jaws. The two foremost that stand next to the Dog-teeth, are less than the rest, having but two Knobs to the Top; but the three hindmost are larger, and have four, being in a manner Four-square.

The two foremost also have but two Roots at most; but the three hindmost commonly three or four. But those of the upper Jaw have, for the most part one Root more than those which are opposite to them in the lower, or however their Roots are larger.

The Reason whereof may be,

First, Because they are pendulous, and so are the apter to drop out: And,

Secondly, Because the Substance of the upper Jaw is not so firm as that of the lower.

The Use of the Teeth, is principally to chew the Meat, to prepare it for the Stomach, that it may the easier concoct into Chyle. The *Incisores* bite off the Morfel, the Dog-teeth break it, and the Grinders make it small; wherefore they are flat in the Top, that they may the better receive and keep the Meat; and rough, that they may grind it the better. The Teeth contribute also to the Formation of the Speech, especially the Fore-teeth; for those that have lost them, Lisp, as we say, and cannot pronounce plainly such Syllables as have C, X, &c.



Mr. *de la Hire* observes, that the *Bone* of the Tooth doth not grow in Adult Persons, but only the *Periostium*; which is a Substance very different from the Bone every way. 'Tis composed, *he saith*, of an infinite Number of small Threads, which are fastened to the Bone by their Roots, much like the *Horns* and *Nails* of Animals; these little Threads grow as the Nails. When a part of the *Periostium* is broke, and the Bone is laid bare, the Tooth usually perishes.

TEINT, is a *French* Term in Painting, signifying that Artificial Colour of which any Object is composed.

TELEPHIUM, is the same Ulcer with *Chironia* (which see;) it is so called from one *Telephius*, who was a long time troubled with this Disease. *Blanchard*.

TELESCOPE [of *τέλεος*, the End, and *σκοπή* of *σκοπέω*, to View, Gr.] is an *Optick* Instrument which serves to discover Objects at a Distance.

If a Telescope consists only of a Convex Object-glass and an Eye-glass of a much greater Convexity (or which is a Portion of a much lesser Sphere) than the Object-glass is (which is the common Form of the Telescope for the Night;) then will the apparent Magnitude of the Object seen through it, be to the Object seen by the naked Eye at the Station of the Object-glass :: as the Focal Length of the Object-glass, to the Focal Length of the Eye-glass. *Molineux Diopt. Nov. Prop. LXII.* Thus;

Suppose the Focal Length of the Object-glass be 12 Foot, or 144 Inches, and that of the Eye-glass 3 Inches; then the apparent Diameter of the Object seen through the Glass, to that seen by the naked Eye, will be as :: 144 to 3, or as 48 to 1. Wherefore such a Telescope will be said to magnify the Diameter of the Object 48 times, and its Surface 2344 times (*i. e.* the Square of 28.)

Wherefore if the same Object-glass be combined with an Eye-glass, whose Focus is 1, and at another time with an Eye-glass whose Focus is 2, the former Telescope will magnify twice as much as the latter.

Also, if two Telescopes have different Lengths, and the Focus of the Eye-glass of the *Shorter* be in the same Proportion to the Focus of its Object-glass :: as the Focus of the Eye-glass of the *Longer* bears to its Object-glass; then those two Telescopes will magnify alike.

But yet long Telescopes are of very great Use, and 'tis impossible to make short ones perform as well: For,

1. Object-glasses of a shorter Focus, will not bear Eye-glasses proportionably short, without colouring the Object, or rendring it dark and obscure.

For Instance: Suppose a very good 12 Foot Object-glass will receive an Eye-glass of no shorter Focus than 3 Inches, with clearness and distinctness; yet however an Object-glass of 24 Foot, equally good, will bear an Eye-glass of less than 6 Inches Focus (perhaps of 5 or 4 Inches Focus) with equal clearness and distinctness.

And then, though an Object-glass of 12 Foot, with an Eye-glass of 3 Inches will magnify but 48 times, as is above proved; yet an Object-glass of 24 Foot, with an Eye-glass of 4 Inches, will magnify 72 times; which is nearer one third more than the former; and this is a vast Advantage.

2. The Image of the Moon, or other Object, in the distinct Base of an Object-glass of 24 Foot, is twice as long as the Image of the distinct Base of an Object-glass of 12 Foot: And consequently the Image in the former will be much more plain and distinct.

Hence may be concluded also, That if the Object-glass be formed on a less Sphere than the Eye-glass, the Appearance of Objects will be diminished in the aforesaid Proportion; as is plain by the Case, when a Telescope is inverted.

Therefore all Persons which relate Phænomena observed by their Telescopes or Microscopes, ought to mention not only the Length of the Tube in general, but also to express the particular Focus of both Eye-glass and Object-glass, together with the Aperture of the Object-glass; or else one cannot well judge of the Degree of magnifying.

To determine the Angle received by a Telescope of this Form, Mr. *Molineux* gives this Rule.

As the Distance between Object and Eye-glass, is to half the Breadth of the Eye-glass :: Radius to the Tangent of the Angle.

If a Telescope consist of a Convex Object-glass, and 3 Convex Eye-glasses (which is the usual Form of Telescopes to be used by Day:) Then the Distance between the first Eye-glass and the second, must be the Sum of their *Foci*; the Distance between the second and third Eye-glasses, must be also the Sum of their *Foci*; so that all the Glasses are distant from the next adjacent Glasses the Sum of their *Foci*; only indeed there may be some little Variety in the Distance between the first and second Eye-glass; which is the Reason there is a *Draw* always made there, to alter it at pleasure.

This Telescope is only a double one of the former Sort; and as the former inverts the Objects, this inverts that Inversion, by the Addition of two more Glasses, and consequently represent all things *Right*, or make them appear *Erect*.

Telescopes may be made with Concave Eye-glasses, but then the Area of the Object will be proportioned always to the Breadth of the Pupil of the Eye of the Beholder; whereas in a Convex Eye-glass, 'tis determined by the Breadth of that Glass.

*The practical Rule for combining, or putting together, this Day-Telescope of Four Glasses, is this.*

Take the two first Eye-glasses, and combine them by Trials, so as to make a distinct inverted Telescope, consisting of a Convex Object-glass, and a Convex Eye-glass of a less Sphere.

Then take the Object-glass, and first Eye-glass, and combine them by Trials also.

Lastly, Take both these Telescopes, and without altering the Distances of their Glasses, in either of them singly, by Trials combine both these Telescopes, 'till the Appearance be clear and distinct.

But what is here done by Trials, may be effected by actual Mensuration, or designing out the Distances of the Glasses from each other, by knowing their Focal Distances.

TELESCOPE *Aerial*, so Mr. *Ch. Huygens* calls a Telescope (described in *Philosophical Transactions*, Numb.



Numb. 161.) which was made for the Night, and to be used without a close Tube (because there is no need of one in a dark Night) and by that means a long Telescope becomes much lightened, and more easily manageable.

TELESCOPE *Reflecting*, of Sir *Isaac Newton*, is made thus: The Tube of it, which is large, is open at the end, which respects the Object; the other end is close, where a concave metalline *Speculum* is laid; and near the open end, there is a flat oval *Speculum* made as small as may be, the less to obstruct the entrance of the Rays of Light into the Tube by it, and inclined towards the upper part of the Tube, where is a little Hole furnished with a small *Plane Convex* Eye-glass: So that the Rays coming from the Object, do first fall upon the Concave placed at the bottom of the Tube, and are thence reflected to the upper end of it, where they meet with the flat *Speculum* obliquely posited, by the Reflection of which they are directed to the little *Plano-convex* Glass, and so to the Spectator's Eye, who looking downwards, sees the Object which the Telescope is turned to. This Instrument is described more at large in *Philos. Transf.* Numb. 81.

After this first Essay, the learned Inventor made another Instrument of the same Nature, with which he saith, that he could read in the *Philosophical Transactions* opened in the Sun-shine, at an hundred Foot Distance, and discern some of the Words at the Distance of 120; its *Aperture* (define next the Eye) was then equal to above an Inch and  $\frac{1}{2}$  of the Object Metal.

The Advantages of this Telescope would be very great, if it could be brought to its desired Perfection. But it is liable to two Inconveniences. First, That 'tis not very easy by it to find the Object you would see; though this a little Use and Practice would obviate; at least, placing a small Prospect-glass on the outside parallel to the Axis of the Cavity of the Catoptrick Tube, you might readily enough find the Object by that, and then the Tube itself would be right. The Second, and much greater Inconvenience is the concave metalline Object-*Speculum* being subject to tarnish, so that it will not continue long good. But if any Person could be so happy as to find out a good metalline Mixture that would polish finely, reflect vividly, and hold without rusting or tarnishing, it would be a Discovery of very great Advantage, both to Telescopic and Microscopical Improvements.

TELESCOPES (1.) Sir *Isaac Newton*, in his admirable Treatise of Opticks, pag. 59. demonstrates, *That the Perfection of Telescopes is impeded by the different Refrangibility of the Rays of Light*; and not, as hath been vulgarly supposed, by the *Spherical Figures* of Glasses: and consequently they will not be perfected by Glasses of the Figures of the *Conick Section*, i. e. by *Parabolick*, *Hyperbolick* Glasses, &c. For having shewed the Ratio between the less and greater Refractions of the different Rays to be very nearly as 27 to 28, he saith, those that are skilled in Opticks, will easily understand, that the least circular Space, into which the Object-Glasses of Telescopes can collect all sorts of parallel Rays, is about the  $27\frac{1}{2}$  part of half the Aperture of the Glass; or the 55th part of the whole Aperture; and that the *Focus* of the most refrangible Rays, is nearer to the Object-Glass than the *Focus* of the less refrangible ones, by about  $27\frac{1}{2}$  part

of the Distance between the Object-Glass and the *Focus* of the mean refrangible ones.

And if Rays of all sorts, flowing from any one lucid Point in the Axis of any *Convex Lens*, be made by the Refraction of the *Lens* to converge to Points not too remote from the *Lens*, the *Focus* of the most infrangible Rays shall be nearer to the *Lens*, than the *Focus* of the least infrangible Rays, by a Distance, which is to the  $27\frac{1}{2}$  part of the Distance of the *Focus* of the mean refrangible Rays from the *Lens*, as the Distance between that *Focus* and the lucid Point from whence the Rays flow, is to the Distance between the lucid Point and the *Lens* very nearly.

After this, he shews, by Experiments, made with very great accuracy, that the Rays of Light, which differ in Refrangibility, do not all converge to the same *Focus*; but if they flow from a lucid Point as far from the *Lens* on the one side, as their *Foci* are on the other, the *Focus* of the most refrangible Rays shall be nearer to the *Lens*, than that of the least refrangible, by above the 14th Part of the whole Distance: And if they flow from a lucid Point so very remote from the Glass, that, before their Incidence, they may be accounted parallel, the *Focus* of the most refrangible Rays shall be nearer to the *Lens*, than the *Focus* of the least refrangible, by a 27th or 28th Part of their whole Distance from it. And the Diameter of the Circle in the middle Space between these two *Foci*, which they illuminate when they fall there on any Plane perpendicular to the Axis (which Circle is the least into which they can be all gathered) is about the 55th Part of the Diameter of the Aperture of the Glass. So that 'tis a wonder that Telescopes do represent Objects so distinctly. But were all the Rays of Light equally refrangible, the Error arising only from the Sphericity of the Figures of Glasses, would be many hundred times less. And expressly by Calculation, pag. 70. he proves, that the Error arising from the spherical Figure of Glasses, to that arising from the different Refrangibility of the Rays is, as 1 to 8151; and consequently is so little, as deserves not to be considered.

There is another Argument (saith our excellent Author, pag. 73.) which proves, that the different Refrangibility of the Rays, is the true Cause of the Imperfection of Telescopes. For the Errors of the Rays arising from the spherical Figures of the Object-glasses, are as the Cubes of the Apertures of such Object-glasses: And thence to make Telescopes, of various Lengths, magnify with equal Distinctness, the Apertures of the Object-glasses, and the *Charges*, or magnifying Powers, ought to be as the Cubes of the square Roots of their Lengths; which doth not answer to Experience. But the Errors of the Rays arising from the different Refrangibility, are as the Apertures of the Object-glasses: And thence to make Telescopes of various Lengths magnify with equal Distinctness, their *Apertures and Charges* ought to be as the square Roots of their Lengths: And this answers to Experience, as is well known. For Instance, a Telescope of 64 Feet in Length, with an Aperture of  $2\frac{2}{3}$  Inches, magnifies about 120 times with as much Distinctness as one of 2 Foot in Length, with  $\frac{1}{2}$  of an Inch Aperture, magnifies 15 times.

By Reason of this different Refrangibility, he concludes that there can scarce be any other means



of improving Telescopes by Refractions alone, besides that of *increasing their Lengths*; for which end the late Contrivance of *Hugenius* seems well accommodated. (See *Philosophical Transactions*, N<sup>o</sup>. 161.) For in his *Aerial Telescope*, the Glasses are readily manageable, and the Object-glasses being upon a strong upright Pole, becomes more steady.

Sir *Isaac Newton*, in his *Opticks*, p. 76, acquaints us how he polished his reflecting Metal, which he used in his reflecting Telescope; and which, because it appears to be a much better way than in any common Use, I here give the Reader.

I had two round Copper-plates, each of six Inches in Diameter, the one Convex, and the other Concave, and ground very true one to another; on the Concave I ground the Object-Metal or Concave, which was to be polished, 'till it had taken the Figure of the Convex, and was ready for a Polish; then I pitch'd it over thinly, by dropping melted Pitch upon it, and warming it, to keep the Pitch soft, whilst I ground it with the Concave Copper, wetted, to make it spread evenly all over the Convex. Thus, by working it well, I made it as thin as a Groat; and after the Convex was cold, I ground it again, to give it as true a Figure as I could. Then I took Putty, which I had made very fine, by washing it from all its gross Particles, and laying a little of this on the Pitch; with the Concave Copper, I ground it upon the Pitch, 'till it had done making a Noise; and then on the Pitch I ground the Object-Metal with a brisk Motion, for about two or three Minutes, leaning hard upon it. Then I put fresh Putty upon the Pitch, and ground it again, 'till it had done making a Noise, and afterwards ground the Object-Metal upon it, as before; and this Work I repeated, 'till the Metal was polished, grinding the last time with all my Strength for a good while together, and frequently breathing upon the Pitch, to keep it moist, without laying on any more fresh Putty.

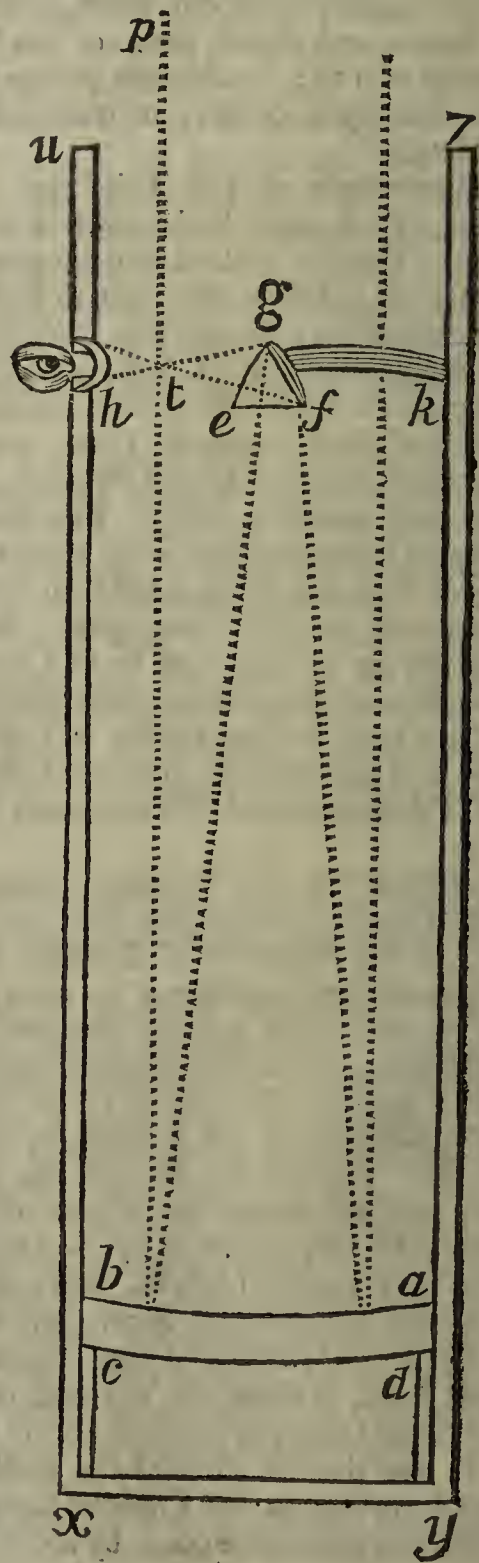
But because Metal is more difficult to polish than Glass, and is afterwards very apt to be spoiled by tarnishing, and besides reflects not so much Light as Glass, Quicksilver'd over, does; I propound, instead of Metal, to use a Glass, ground Concave on the Fore-side, and as much Convex on the Back-side, and on the Back-side well Quicksilver'd over; the Glass also must be exactly all over of the same thickness, otherwise the Object will look coloured and indistinct.

With such a Glass I tried, about five or six Years ago, to make a Reflecting-Telescope of four Feet in Length, to magnify about 150 times: And I satisfied myself, that there wants nothing but a good Artist to bring this Design to Perfection: For the Glass being only after the common Manner of grinding Glasses for Telescopes, though it seemed as good as Object-glasses used to be, yet when it was Quicksilvered, the Reflexion discovered innumerable Inequalities all over the Glass: And by Reason of these Inequalities, Objects appeared indistinct in this Instrument. For the Errors of *Reflected Rays*, caused by any Inequality of the Glass, are about six times greater than the Errors of *Refracted Rays*, caused by the like Inequalities. But I however found by this Tryal, that the Reflexion on the Concave side of the Glass, which I feared would disturb the Vision, did really no sensible prejudice to it; and consequently, that nothing is wanting to perfect these Telescopes but good Workmen, who can grind and polish Glasses

truly spherical. I once mended a common fourteen Foot Object-glass considerably, by grinding it with Pitch or Putty, and leaning very easily on it in the grinding it, lest the Putty should scratch it: besides, leaning too hard on the Glass in grinding it, is apt to bend it; and then the Figure cannot be truly spherical.

Sir *Isaac Newton's* Method of shortning Telescopes, *vid.* his *Opticks*, pag. 29.

Let *abde* represent a Glass spherically Concave on the Fore-side *ab*, and as much convex on the Back-side *cd*, so that it be every where of an equal thickness; for it must not be thicker on one side than the other, lest it make Objects appear coloured and indistinct: It must also be very well wrought and Quicksilvered over on the Back-side: Place this Glass in the Tube *vxzy*, which must be made very black within. Let *efg* represent a Prism of Glass or Chrystal, placed near the other end of the Tube, in the middle of it, by means of an Handle of Brass or Iron *fgk*, to whose end made flat, it is cemented. Let this Prism be Right-angled at *e*, and the other two Angles exactly equal, and consequently each 45 Degrees. Let the Sides *ef* and *ge* be exactly Plane and Square, and by consequence the third Side *fg*, a Rectangled Parallelogram, whose Length is to its Breadth in a subduplicate Proportion of 2 to 1.





Let this Prism be so placed in the Tube, that the Axis of the Concave Speculum may pass thro' the middle of the square Side  $ef$  perpendicularly, and, consequently, thro' the middle of the Side  $fg$ , at an Angle of 45 Degrees. And let the Side  $ef$  be turned towards the Speculum, and the Distance of this Prism from the Speculum be such, that the Rays of the Light  $pq$ ,  $rs$ , &c. which are incident upon the Speculum in Lines parallel to the Axis thereof, may enter the Prism at the Side  $ef$ , and be reflected by the Side  $fg$ , and thence go out of it thro' the Side  $ge$  to the Point  $t$ , which must be the common Focus of the Speculum  $abcd$ , and of a Plane Convex Eye-glass  $h$ , thro' which those Rays must pass to the Eye. And let the Rays at their coming out of the Glass pass thro' a small round Hole, or Aperture, made in a little Plate, Lead, Brass, or Silver, wherewith the Glass is to be covered; which Hole must be no bigger than is necessary for Light enough to pass thro': for so it will render the Object distinct; the Plate in which it is made, intercepting all the erroneous Part of the Light which comes from the Verges of the Speculum  $ab$ .

Such an Instrument well made, if it be 6 Foot long (reckoning the Length from the Speculum to the Prism, and thence to the Focus  $t$ .) will bear an Aperture of 6 Inches at the Speculum, and magnify between 2 and 300 times. But the Hole  $h$ , here limits the Aperture with more advantage, than if the Aperture were placed at the Speculum.

If this Instrument be made longer or shorter, the Aperture must be in proportion, as the Cube of the square Root of the Length, and the magnifying as the Aperture. But it is convenient, that the Speculum be, at least, an Inch or two broader than the Aperture; and that the Glass of the Speculum be thick, that it bend not in the working. The Prism  $efg$ , must be no bigger than is necessary, and its back-side  $fg$  must not be Quicksilvered over; for without Quicksilver it will reflect all the Light incident on it from the Speculum.

In this Instrument the Object will be inverted, but may be erected by making the Sides  $ef$ , and  $eg$  of the Prism  $efg$ , not plain but spherically convex, that the Rays may cross as well before they come at it, as afterwards between it and the Eye-glass.

If it be desired that the Instrument bear a larger Aperture, that may be also done, by composing the Speculum of two Glasses, with Water between them.

The Reason why four Glasses in a Telescope represent the Object erect, Mr. *Molyneux* shews plainly in *Philosophical Transactions*, N<sup>o</sup>. 183.

Mr. *Auzout* saith, in *Philosophical Transactions*, N<sup>o</sup>. 4. That the Apertures of Telescopes ought to be in a Sub-duplicate Ratio of their Lengths; but this must be taken, so as to allow for the Quantity of Light which comes into the Tube; for the more Light comes in, the greater the Aperture must be, saith Dr. *Hook*, *ibid*. And Dr. *Hook* also doth there shew a way to make a Plane Convex-glass of a small Sphere collect the Rays at a great Distance; but I don't find that he ever made any considerable Use of it afterwards.

Mr. *De la Hire* saith, in the *Memoirs de l'Academie Royal des Sciences*, for May 1699. That to prevent the Dew falling on the Object-glass of a

Telescope in a nocturnal Observation, 'tis a very good way to make a Tube of coarse brown Paper.

### Of Refractions.

The Meridian Altitudes of two fixed Stars, which are equal, or a small matter different, the one being North, and the other South, being observed, and also their Declination otherways given; to find the Refraction answering to the Degrees of Altitude of the said Stars, and the true Height of the Pole, or Equator, above the place of Observation.

Having found the apparent Meridian Altitude of some Star near the Pole (by the aforesaid Directions) if the Complement of the said Star's Declination be added thereto, or taken therefrom, we shall have the apparent Height of the Pole. After the same manner may also the apparent Height of the Equator be found, by means of the Meridian Altitude of some Star near the Equator; in adding or subtracting its Declination.

Then these Heights of the Pole and Equator being added together, their Sum will always be greater than a Quadrant; but 90 Degrees being taken from this Sum, the Remainder will be double the Refraction of either of the Stars observed at the same Height: and therefore taking the said Refraction from the said apparent Height of the Pole, or Equator, we shall have their true Altitude.

*Note*, The Refraction and Height of the Pole found according to this way, will be so much the more exact, as the Altitude of the Stars is greater; for if the difference of the Altitude of each Star should be even 2 Degrees, when their Altitudes are above 30 Degrees, we may by this Method have the Refraction, and the true Height of the Pole, because in this Case the Difference of Refraction in Altitudes differing two Degrees, is not sensible.

### Another Way of observing Refractions.

The Quantity of Refraction may also be found by the Observations of one Star only, whose Meridian Altitude is 90 Degrees, or a little less; for the Height of the Pole or Equator above the Place of Observation being other ways known, we shall have the Stars true Declination, by its Meridian Altitude, because Refractions near the Zenith are insensible.

Now if we observe by a Pendulum the exact Times when the Star comes to every Degree of Altitude, as also the Time of its Passage by the Meridian, which may be known by the equal Altitudes of the Star, being East and West, we have three things given in a spherical Triangle; *viz.* the Distance between the Pole and Zenith, the Complement of the Star's Declination, and the Angle comprehended by the aforesaid Arcs; namely, by the Difference of mean Time, between the Passage of the Star by the Meridian and its place, converted into Degrees and Minutes; to which must be added the convenable proportional Part of the mean Motion of the Sun in the Proportion of 59 Minutes 8 Seconds *per Day*: Therefore the true Arc of the vertical Circle between the Zenith and the true Place of the Star may be found.

But the apparent Arc of the Altitude of the Star is had by Observation, and the Difference of these Arcs will be the Quantity of Refraction at the Height of the Star. By a little Calculation the Refraction of every Degree of Altitude may be found.



The same may be done by means of the Sun, or any other Star, provided its Declination be known, to the end that at the Time of Observation, the true Distance of the Sun or Star from the Zenith may be found.

The Refractions of Stars being known, it will then be easy to find the Height of the Pole; for having observed the Meridian Altitude of the Polar-Star, as well above as below the Pole, the same Day, and having diminished each Altitude by its proper Refraction, half of the Difference of the corrected Altitudes, added to the lesser Altitudes corrected, or subtracted from the greater Altitudes thus corrected, will give the true Height of the Pole.

Mr. *de la Hire* has observed with great care, for several Years, the Meridian Altitudes of fixed Stars, and principally of *Sirius*, and *Lucida Lyra*, with Astronomical Quadrants, very well divided, and very good Telescopes at different Hours of the Day and Night, and at different Seasons of the Year; and he assures us, that he never found any difference in their Altitudes, but what proceeded from their proper Motions.

And because *Sirius* comes to about the 26 Degree of the Meridian, we might doubt whether in the lesser Altitudes, the Refractions in the Winter would be greater than those in the Summer: Hence he also observed, with the late M. *Picard*, the lesser Meridian Altitudes of the Star *Capilla*, which is about  $4\frac{1}{2}$  Degrees, at several different Times in the Year.

Having compared these different Observations together, and made the necessary Reductions, because of the proper Motion of that Star, there was scarcely found one Minute of Difference that could proceed from any other Cause but Refraction. Therefore he made but one Table of the Refraction of the Sun, Moon, and the Stars, for all Times of the Year, conformable to the Observations that he made from them.

Notwithstanding this, one would think that Refractions near the Horizon are subject to divers Inconstancies, according to the Constitution of the Air, and the Nature of high or low Grounds, as M. *de la Hire* has often found; for observing the Meridian Altitudes of Stars at the Foot of a Mountain, which seemed to be even with the Top of it, they appeared to him a little higher, than if he had observed them at the Top: but if the Observations of others may be depended upon, Refractions are greater, even in Summer in the frozen Zones, than in the temperate Zones.

How to find the Time of the Equinox and Solstice by Observation: Having found the Height of the Equator, the Refraction and the Sun's Parallax at the same Altitude, it will not afterwards be difficult to find the Time in which the Centre of the Sun is in the Equator; for if from the apparent Meridian Altitude of the Centre of the Sun, the same Day as it comes to the Equinox, be taken the convenient Refraction, and then the Parallax be added thereto, the true Meridian Altitude of the Sun's Centre will be had. Now the Difference of this Altitude, and the Height of the Equinoctial, will shew the Time of the true Equinox before or after Noon: And if the Sum of the Seconds of that Difference be divided by 59, the Quotient will shew the Hour or Fractions that must be added or subtracted from the true Hour of Noon, to have the Time of the true Equinox.

The Hours of the Quotient must be added to the Time of Noon, if the Meridian Altitude of the Sun be lesser than the Height of the Equator about the Time of the Vernal Equinox; but they must be subtracted, if it be found greater. You must proceed contrariways when the Sun is near the Autumnal Equinox.

*Example*, The true Height 41 Degrees, 10 Minutes of the Equator being given, and having observed the true Meridian Altitude 41 Degrees, 5 Minutes, 15 Seconds of the Sun, found by the apparent Altitude of its upper or lower Limb, corrected by its Semi-diameter, Refraction, and Parallax; and the Difference will be 4 Minutes, 45 Seconds, or 285 Seconds, which being divided by

59, the Quotient will be  $4\frac{49}{59}$  that is, 4 Hours,

48 Minutes, which must be added to Noon, if the Sun be in the Vernal Equinox; and, consequently, the Time of the Equinox will happen 4 Hours, 48 Minutes after Noon. But if the Sun was in the Autumnal Equinox, the Time of the said Equinox would happen 4 Hours, 48 Minutes before Noon; that is, at 12 Minutes past Seven in the Morning.

As to the Solstices, there is much more difficulty in determining them than the Equinoxes, for one Observation only is not sufficient; because about this Time the Difference between the Meridian Altitudes in one Day, and the next succeeding Day, is almost insensible.

Now the exact Meridian Altitude of the Sun must be taken, 12 or 15 Days before the Solstice, and as many after, and so on may find the same Meridian Altitude by little and little; to the end that by the proportional Parts of the Alteration of the Sun's Meridian Altitude, we may more exactly find the Time wherein the Sun, if found at the same Altitude, before and after the Solstice, being in the same Parallel to the Equator.

Now having found the Time elapsed between both the Situations of the Sun, you must take half of it, and seek in the Tables the true Place of the Sun at these three Times. This being done, the Difference of the extreme Places of the Sun must be added to the mean Place, in order to have the mean Place, with comparison to the Extremes; but if the mean Place, found by Calculation, does not agree with the mean Place, found by Comparison, you must take the Difference, and add to the mean Time, the Time answering to that Difference, if the mean Time found by Calculation be lesser; but contrariways, it must be subtracted if it be greater, in order to have the Time of the Solstice.

The true Time between the Passages of two fix'd Stars by the Meridian being given, or else of a fixed Star and a Planet, to find their ascensional Difference.

The given Time between their Passages by the Meridian must be converted into Degrees of the Equator, and the right Ascension of the true Motion of the Sun answering to that Time, must be added thereto; then the Sum will be the ascensional Difference sought.

*Example*, Suppose between three Passages by the Great Dog, called *Sirius*, by the Meridian, and the Heart of the Lion, named *Regulus*, there is elapsed 3 Hours, 20 Minutes of Time, and the right Ascension of the true Motion of the Sun, let it be 7 Minutes, 35 Seconds; whence converting 3 Hours, 20 Minutes into Degrees of the Equator, and there will be had 50 Degrees; to which adding 7 Minutes, 35 Seconds,



35 Seconds, and the Sum 50 Degrees, 7 Minutes, 35 Seconds, will be the ascensional Difference between *Sirius* and *Regulus*.

You must proceed thus for the ascensional Difference of a fixed Star and a Planet, or of two Planets; yet, *Note*, if the proper Motion of the Planet or Planets be considerable between both their Passages by the Meridian, regard must be had thereto.

### *How to observe Eclipses.*

Amongst the Observations of Eclipses, we have the Beginning, the End, and the total Emerfion; which may be exactly enough estimated by the naked Eye, without Telescopes, except the Beginning and the End of Eclipses of the Moon, where an Error of one or two Minutes may be made; because 'tis difficult certainly to determine the Extremity of the Shadow. But the Quantity of the Eclipse, that is the eclipsed Portion of the Sun and Moon's Disk, which is measured by Digits, or the 12th parts of the Sun and Moon's Diameter, and Minutes, or the 60th parts of Digits, cannot be known without a Telescope joined to some Instrument. For an Estimation made by the naked Eye, is very subject to Error, as it is easy to see in History of antient Eclipses, although they were observed by very able Astronomers.

The Astronomers who first used Telescopes, furnished with but two Glasses; namely, a Convex Object-glass, and a Concave Eye-glass, in the Observations of Eclipses, observed those of the Sun, in the following manner.

They caused a Hole to be made in the Window-shutter of a Room, which Room in the Day-time, when the Shutters were shut, was darkened thereby; through which Hole they put the Tube of a Telescope, in such manner, that the Rays of the Sun, passing through the Tube, might be received upon a white piece of Paper, or a Table-cloth, upon which was first described a Circle of a convenable bigness, with five other concentric Circles, equally distant from one another, which with the Centre, divided a Diameter of the outward Circle into twelve equal Parts. Then having adjusted the Table-cloth perpendicular to the Situation of the Tube of the Telescope, the luminous Image of the Sun was cast upon the Table-cloth, which would still be greater according as the Table-cloth was more distant from the Eye-glass of the Telescope; whence by moving the Tube forwards and backwards, they found a Place where the Image of the Sun appeared exactly equal to the outward Circle, and at that Distance they fixed the Table-cloth, with the Tube of the Telescope, which composed the Instrument for the said Observation. Afterwards they moved the Tube according to the Sun's Motion, to the end that the luminous Limb of its Disk might every where touch the outward Circle described upon the Table-cloth; by which means the Quantity of the eclipsed Portion was seen, and its greatest Obscurity measured by the concentric Circles, they denoted the Hour of every Phase, by a Second Pendulum Clock, rectified and prepared for that purpose. The same Method is still observed by many Astronomers, who use also a circular Reticulum, made with six concentric Circles upon very fine Paper, which must be oiled to hinder the Sun's Image more sensible. The greatest of the Circles ought

exactly to contain the Image of the Sun in the *Focus* of the Object-glass of a Telescope of 40 or 60 Feet; the six Circles are equally distant, and divide the Diameter of the Sun into twelve equal Digits. When the Paper is placed in the *Focus* of a great Telescope, the enlightned part of the Sun will very distinctly be seen, then the Eye-glass is not used.

There are others that use a Telescope, furnished with two Convex-glasses, from whence the same Effect follows. But although the use of a Telescope in this matter be very proper to observe Eclipses of the Sun, yet it is not fit to observe Eclipses of the Moon, because its Light is not strong enough.

*Lastly*, Others place a Micrometer in the common *Focus* of the Convex-Lenses. Besides the Quantity of the Phases of the Sun and Moon (easily known by the said Micrometer) we may have the Diameters of the Luminaries, and the Proportion of the Earth's Diameter to the Moon's, as well by the obscure Portion of its Disk, as by the luminous Portion, and the Distance between its Horns.

The Method of observing Eclipses by means of the Micrometer, will be much better, if the Divisions, to which the parallel Hairs are applied, be made so, that six Intervals of the Hairs, may contain the Diameter of the Sun or Moon: For the moveable Hair, posited in the Middle of the Distance, between the moveable ones (which is not difficult to do) will shew the Digits of the Eclipses.

The same Telescope and Micrometer may serve for all the other Observations, and to measure Eclipses; as to observe the Passage of the Earth's Shadow over the Spots of the Moon in Lunar Eclipses.

There yet remains one considerable Difficulty, and that is, to make a new Division of the Micrometer, serving as a common Reticulum for all Observations; for it scarcely happens in an Age in two Eclipses, that the apparent Diameters of the Sun and Moon are the same.

Therefore *M. de la Hire* has invented a new Reticulum, which having all the Uses of the Micrometer, may serve to observe all Eclipses, it being adapted to all apparent Diameters of the Sun and Moon; and its Divisions are firm and solid enough to resist all the Vicissitudes of the Air, although they are as fine as Hairs.

The Construction and Use of this Reticulum is thus: First, Take two Object-Lenses of Telescopes of the same Focus, or nighly the same, which join together: As for Example, The Focus of two Lenses together of eight Feet, which is the fit Length of a Telescope for observing Eclipses, unless the Beginning and the End of Solar ones, which require a longer Telescope, exactly to determine them.

Secondly, We find from Tables, that the greatest Diameter of the Moon at the Altitude of 90 Degrees is 34 Minutes, 6 Seconds, to which adding 10 Seconds, and there will arise 34 Minutes and 16 Seconds. Therefore say, As Radius is to the Tangent of 17 Minutes, 8 Seconds (the half of 34 Minutes, 16 Seconds) So is eight Feet, or the focal Length of the two Lenses to the Parts of a Foot, which doubled, will subtend an Angle of 34 Minutes, 16 Seconds, in the Focus of the Telescope, and this will be the Diameter of the said circular Reticulum.

Thirdly,



Thirdly, Upon a very flat, clear, and well polished Piece of Glas, describe lightly with the Point of a Diamond, fasten'd to one of the Legs of a Pair of Compasses, fix concentric Circles, equally distant from each other; the Semidiameter of the greatest and last, let be equal to the fourth Term before found; likewise draw two Diameters to the greatest Circle at Right-Angles: The flat Piece of Glas being thus prepared, and put into the Tube, of which we have before spoken; and in the Focus of the Telescope will be a very proper Reticulum for observing Solar and Lunar Eclipses, and it will divide all the apparent Diameters into twelve equal Parts or Digits, as we are now going to explain.

It is manifest from Dioptrics, that all Rays coming from Points of a distant Object, after their Refraction by two convex Lenses, either join'd or something distant from each other, will be painted in the common Focus of the said Lenses; which will appear so much the greater, according as the Lenses be distant from one another; so that they will appear the smallest when the Lenses are joined together: Therefore if the Object-Glasses used in this Construction, be each put into a Tube, and one of these Tubes slides within the other; then the said Lenses, being thus joined, the Image of a distant Object, whose Rays fall upon the Lenses under an Angle of 34 Minutes, 16 Seconds, will exceed the Moon's greatest apparent Diameter by 10 Seconds: therefore in moving the Lenses by little and little, such a Position may be found, wherein the Diameter of the greatest Circle on the Reticulum posited in the Focus, will answer to an Angle of 34 Minutes, 16 Seconds; for the Image of an Object perceived under a less Angle, may be equal to the Image of the same Object perceived under a greater Angle, according to the different Lengths of the Foci; but the Reticulum is in a separate Tube, and so it may be removed at a Distance at Pleasure from the Object-Glasses. We now proceed to lay down two different Ways of finding the Positions of the Lenses and Reticulum, proper to receive the different Diameters of the Sun and Moon.

First, In a very level and proper Place for making Observations with Glasses, place a Board, with a Sheet of Paper thereon, directly exposed to the Tube's length, having two black Lines drawn upon it parallel to each other, and at such a Distance from each other, that it subtends an Angle of 34 Minutes, 6 Seconds; so that the Distance of the said two Lines, represented in the Focus of the Object-Glasses, may likewise subtend an Angle of 34 Minutes, 6 Seconds: And this may be found in reasoning thus (as we have already done for the Micrometer) As Radius is to the Tangent of 17 Minutes, 3 Seconds, So is the Distance from the Tube of the Object-Glasses to the Board, to half of the Distance that the parallel Lines on the Paper must be at. And thus we shall find, by Experience, the Place of each Object-Glas, and the Reticulum in the common Focus, in such manner, that the Representation of the two black Lines on the Paper, embarrasses entirely the Diameter of the greatest Circle of the said Reticulum. Now we set down 34 Minutes, 6 Seconds upon the Tubes, in each Position of the Lenses and their Foci, or the Reticulum, that so the Lenses and Reticulum may be adjusted to their exact Distance, every time an Angle of 34 Degrees, 6 Minutes is made use of.

Again, let the said Board and white Paper be placed farther from the Tube, in such manner, that the Distance between the parallel Lines on the Paper subtend, or is the Base of an Angle of 33 Minutes, for *Example*, whose Vertex is at the Lenses of the Telescope; which may be done, in saying: As the Tangent of 16 Minutes, 30 Seconds, is to Radius; So is half the Interval of the parallel Lines on the Paper, to the Distance of the Board from the Lenses. Now in this Position of the Telescope and Board, the Position of the Lenses and Reticulum between themselves must be found; so that the Representation of the parallel Lines, which appear very distinctly in the *Focus* of the Lenses, occupies the whole Diameter of the greatest Circle on the Reticulum. This being done, the Number 33 Minutes, must be made upon the Tubes, in the places wherein each of the Lenses and Reticulum ought to be. Proceed in this manner, for the Angles of 32 Minutes, 31 Minutes, 30 Minutes, and 29 Minutes.

If the Distances, denoted upon the Tubes between the different Positions of the Lenses and the Reticulum, answering to a Minute, be divided into 60 equal Parts, we shall have their Positions for every Second; and by this means the same Circle of the Reticulum may be accommodated to all the different apparent Diameters of the Sun and Moon; and the Diameter of the greatest Circle being divided into twelve equal Parts, it will serve to measure the Quantities of all Solar and Lunar Eclipses.

**TELESCOPICAL-Stars**, are those that are not visible to the naked Eye, but discoverable only by the Help of a *Telescope*.

**TELLER**, is an Officer in the *Exchequer* (of which there are four) who receive all Moneys due to the King, and gives the *Clerk of the Pell* a Bill to discharge him therewith. They pay also all Money payable to the King, by Warrant from the *Audi or of the Receipt*, and make weekly and yearly Books of all Receipts and Payments, which they deliver to the Lord Treasurer.

**TEMPERATE Zone**.

**TEMPORALIS**, also *Crotaphites*, is a Muscle of the upper Jaw, which has a large semicircular fleshy Beginning, from part of the *Os Frontis*, *Syn-cipitis*, *Sphænoides*, and *Temporalis*; from these Places its Fibres pass (like Lines drawn from a Circumference to a Centre) under the *Os Jugale*, from whence also arise some fleshy Fibres joining with the former at their united, partly tendinous, and partly fleshy Insertion, to the upper part of the *Processus Coronæ* of the lower Jaw: This, with its Partner, draws the lower Jaw upwards.

**TEMPORALTIES** of Bishops, are such Revenues, Lands, Tenements, or Lay-Fees, which have been laid or annexed to Bishops Sees by our Kings, or other Persons of high Rank in the Kingdom.

**TEMPORA**, in *Anatomy*, a double Part of the Head, reaching from the Forehead and Eyes to both Ears.

**TEMPORUM Offa**, are Bones of the Skull, situated in the lower part of the Sides of the *Cranium*; their upper part, which is thin, consisting only of one Table, is of circular Figure, and is joined to the *Offa Parietalia* by the *Suturæ Squamosæ*; their lower part, which is thick, hard, and unequal, is joined to the *Os Occipitis*, and to the *Os*



*Os Petrosum*; they have each three external *Apo-physes* or *Processus*, viz. *Processus Zygomaticus*, *Mammillaris* or *Mastoidæus*, and the *Processus Styloformis*, and one Internal. In the temporal Bones, there are two Internal, and 4 External Holes. The first of the Internal, is the Hole through which the Auditory Nerve passes; the second is common to it and the *Os Occipitis*; the 8th Pair of Nerves, and the lateral *Sinus* passes through it. The first of the External, is the *Meatus Auditorius Externus*; the second is opened behind the Palate, it is the end of that Passage which comes from the Barrel of the Ear to the Mouth. The third is the Orifice of the Conduit, by which the Carotid Arteries enter the *Cranium*; and the fourth is behind the *Processus Mastoidæus*; but it passes a Vein which carries the Blood from the external Teguments to the lateral *Sinus's*; sometimes this Hole is wanting; there is another which is between the *Processus Mastoidæus*, and the *Styloformis*, through which the *Portio dura* of the Auditory Nerve passes. They have each a *Sinus* lined with a Cartilage under the *Meatus Auditorius*, which receives the Conduyle of the lower Jaw.

TEMPORARY *Fortification*. See *Fortification*.

TENAILLE, in *Fortification*, is a kind of Out-work resembling a *Horn-work*, but generally somewhat different, in regard that instead of two Demi-bastions, it bears only in Front a Re-entring Angle between the same Wings without Flanks; and the Sides are parallel: But when there is more breadth at the *Head* than at the *Gorge*, these *Tenailles* are called *Queue d'aronde*.

TENAILLE *Double* or *Flank'd*, is a Work whose Front consists of four Faces, making two *Re-entring Angles*, and three *Saliant*; the Wings or Sides of this Work being in the like manner correspondent in the Front of the *Gorge*.

TENAILLE *Simple*, is a Work having its Front form'd by two Faces, which make a *Re-entring Angle*, the Sides running directly parallel from the Head to the *Gorge*.

TENAILLE *of the Place*, is that which is comprehended between the Points of two neighbouring Bastions; that is to say, the *Curtain*; the two *Flanks* that are raised on the *Curtain*, and the two Sides of the *Bastions* which face one another: So that 'tis the same with what is otherwise called, *The Face of the Fortrefs*.

All *Tenailles* are defective in this respect, That they are not Flanked or Defended towards their *inward* or *dead Angle*; because the Height of the *Parapet* hinders seeing down before the Angle, so that the Enemy can lodge himself there under Covert: Wherefore *Tenailles* are never made but when they want time to make a *Horn-work*.

TENAILLE, *of the Foss* of a Ditch; is a low Work raised before the *Curtain*, in the middle of the *Foss*: It is of three Sorts; the first is composed of a *Curtain*, two *Flanks* and two *Faces*: The *Rampart* of the *Curtain*, including the *Parapet* and *Talus*, is but five Fathom thick, but the *Rampart* of the *Flanks* and *Faces* is seven. The Second, which *Vauban* saith he found to be of very good Defence, is composed only of two *Faces* made on the Lines of Defence, whose *Rampart* and *Faces* are parallel. The Third fort differs from the Second, only in that its *Rampart* is parallel to the *Curtain* of the *Place*. All three forts are good, and cannot be hurt by the *Besiegers Cannon*, 'till they are

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Masters of the *Covert-way*, and have planted their Cannon there.

TENANT, or *Tenant*, is one that holds or possesses Lands or Tenements by any kind of Right, either in Fee for Life, Years, or at Will. And 'tis used in Law, with divers Additions, as *Tenants in Dower*, which she that possesses Land by Virtue of her *Dower*.

*Tenant per Statute-Merchant*, that holds Land by Virtue of a Statute forfeited by him.

*Tenant, in Frank-Marriage*, is he that holds Lands or Tenements by Virtue of a Gift thereof made to him upon Marriage between him and his Wife.

*Tenant by the Courtesy*, that holds for his Life, by Reason of a Child begotten by him of his Wife, being an Inheretrix, and born alive.

*Tenant by Elegit*, that holds by Virtue of the Writ called an *Elegit*.

*Tenant in Mortgage*, that holds by means of a *Mortgage*.

*Tenant by the Verge*, in ancient *Demesne*, is he that is admitted by the Rod in the Court of ancient *Demesne*.

*Tenant by Copy of Court-Roll*, is one admitted *Tenant* of any Lands, &c. within a Manor, which Time out of Mind have been demisable, according to the Custom of the Manor.

*Tenant by Charter*, is he that holdeth by Feoffment in Writing, or other Deed.

*Tenant in Chief*, that holdeth of the King in Right of his Crown.

*Tenant of the King*, is he that holds of the Person of the King, or as some Honour.

*Very Tenant*, that holds immediately of his Lord: For if there be Lord, *Mesne* and *Tenement*, the *Tenant* is *very Tenant* of the *Mesne*, but not to the Lord above.

*Joint-Tenants*, such as have equal Right in Lands and Tenements, by Virtue of one Title.

*Tenants in Common*, that have equal Right, but hold by divers Titles.

*Particular Tenant*, he that holds only for this Term.

*Sole Tenant*, is he that hath no other joined with him.

*Several Tenant*, is opposite to *Joint-Tenant*, or *Tenant in common*.

*Tenant al Præcipe*, is he against whom the Writ *Præcipe* is to be brought.

*Tenant in Demesne*, is he that holdeth the Demesne of a Manor for a Rent without Service.

*Tenant by Execution*, is he that holds by Virtue of an Execution upon any Statute, Recognisance, &c.

There was also *Tenant by Knight-Service*, *Tenant in Burgage*, *Tenant in Socage*, *Tenant in Frank-fee*, *Tenant in Villenage*: And there is *Tenant in Fee-simple*, *Tenant in Fee-tail*, *Tenant upon Sufferance*, &c.

TENAR (the same with the *Abductor Pollicis*) is with some, the Name of the Muscle which serves to draw the Thumb from the Fingers.

TENASMUS. See *Tenesmus*.

TENDER, in a legal Sense, signifies as much as carefully to offer, or circumspectly endeavour the Performance of any thing belonging to us. As to *tender Rent*, is to offer it at the Time and Place where and when it ought to be paid. To *tender*



*his Law Summons*, is to offer himself ready to make his Law, whereby to prove that he was not summoned.

**TENDON**, is a similar nervous Part annexed to Muscles and Bones, whereby the voluntary Motion of the Members is chiefly performed. The generality of Surgeons scarce ever distinguish betwixt a *Tendon* and a Nerve.

**TENEMENT**, signifies the House or Land that a Man holdeth of another; and when joined with *Frank*, it contains Lands, Houses and Offices, wherein we have Estate for Term of Life, or in Fee.

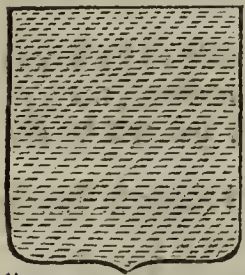
**TENEMENTIS Legatis**, is a Writ that lies to *London*, or any other Corporation, (where the Custom is, That Men may demise Tenements as well as Goods and Chattels by their last Will) for the Hearing any Controversy touching the same, and for rectifying the Wrong.

**TENENT**, in *Heraldry*, something that sustains or supports a Shield or Armoury; much the same as *Supporter*.

**TENENTIBUS in assis non onerandis**, &c. is a Writ that lieth for him to whom a Disseisor hath alienated the Land whereof he disseiseth another, that he be not molested for the Damages awarded, if the Disseisor have wherewithal to satisfy them himself.

**TENESMUS**, *Tenasmus*, is a continual Desire of going to Stool, yet attended with an Inability of doing any thing, but sometimes voiding of bloody and slimy Matter. *Blanchard*.

**TEN-FOOT Rod**. See *Station-Staff*.



**TENNE**, in *Heraldry*, is what is commonly in *English* call'd Tawny, and some call it Brusk: The Colour is made of red and yellow mix'd together, and is express'd in engraving by Lines diagonal from the Sinister Chief and Traverse. In Blazoning by celestial Things, it is call'd the Dragon's Head, and by precious Stones, the Hyacinth. See the Figure.

**TENON**, in *Architecture*, is the square End of a Piece of Timber fitted into a Mortise.

**TENOR**, is the Name of the first Mean or middle Part in *Musick*.

**TENORE indictamenti mittendo**, is a Writ whereby the Record of an Indictment, and the Process thereupon, is called out of another Court into the *Chancery*.

**TENSORS**, or *Extensors*, are those common Muscles that serve to extend the Toes, and have their Tendons inserted into all the lesser Toes.

**TENTHS**, is that yearly Portion or Tribute which all Ecclesiastical Livings pay to the King.

**TENURE**, a Term in Law, signifying the Manner whereby Tenements are holden of their Lords; what may make a *Tenure*, and what not. See *Perkins Cap. 10. Reservation 70*, where you'll find most of those *Tenures* that are now used in *England*.

**TEREBRUM**. See *Mediolus*.

**TERES Major**, is a Muscle which arises from the inferior Angle of the *Scapula*, and becoming a round fleshy Body, ascends obliquely with the former, but then passeth under the superior Head of the *Gemellus*, and makes a short flat Tendon, inserted below the Neck of the *Os Humeri*, close to that of the Muscle called *Anisclaptor* or *Latissimus Dorsi*.

**TERES Minor**, is a Muscle of the Arm, so called from its Figure and Magnitude, to distinguish it from the *Teres Major*.

This Muscle is in some Bodies confounded with the *Infra-spinatus*, but in others it is distinct. It arises fleshy from the lower Part of the inferior *Costa* of the *Scapula*, and descends obliquely over the superior Head of the *Gemellus Major*, where becoming tendinous, it is inserted to the Head of the *Os Humeri*: When this acteth, the Arm is moved backwards and downwards.

**TERGIFOETOUS Plants**, such Herbs (as the *Capillaries*) as bear their Seeds on the back sides of their Leaves, are for that Reason called by some Botanists *Tergifætæ*.

**TERM**, in Geometry, is sometimes taken for the Bounds and Limits of any thing; as a Point is the Term of a Line, a Line of a Superficies, and a Superficies of a Solid: And this is what the Schools call *Terminus Quantitatis*.

**TERM**, in Law, signifies the Bounds and Limitation of Time, as a Lease for Term of Life or Years. But 'tis most commonly used for that Time wherein the Tribunals or Places for Judgment are open to all that think fit to complain of Wrong, or to seek their own by due Course of Law, or Action; the rest of the Year is called *Vacation*.

Of these Terms there be Four in every Year, during which Time Matters of Justice are dispatched.

One is called *Hillary Term*, which begins the 23d Day of *January*, or if that be *Sunday*, then the next Day after, and endeth the 12th of *February* following.

The Second is *Easter Term*, which begins the *Wednesday* Fortnight after *Easter-Day*, and ends the *Monday* next after *Ascension-day*.

The Third is *Trinity Term*, beginning the *Friday* next after *Trinity-Sunday*, and ending the *Wednesday* Fortnight after.

The Fourth is *Michaelmas Term*, which begins the 23d of *October*, unless it be *Sunday*, and then the Day after, and ends the 28th of *November* following.

**TERMINTHUS**, [τερινθος, Gr.] is a Swelling in the Thighs, with a black Pimple at the top, as big as the Fruit of the Turpentine-Tree. *Blanchard*.

**TERMS of an Equation in Algebra**, are the several Names or Members of which it is composed, and such as have the same unknown Letter, but in different Powers or Degrees. For if the same unknown Letter be found in several Members in the same Degree or Power, they all pass but for one Term.

Thus in this Equation  $aa + ab = R$ , the three Terms are,  $aa$ ,  $ab$  and  $R$ .

And in this,  $aa + ab + ac = Rd + dc$ ; the Terms are,  $aa$ ,  $ab + ac$ , and  $Rd + dc$ ; which are but 3, because  $ab + ac$ , having  $a$  in the same Dimensions in both Parts, is taken but for one Term. Hence the first

Term in any Equation must be that, where the unknown Root hath the highest Dimensions; and that Term which hath the Root in it of one Dimension of Power lower, is called the *second Term*, and so on.

*Des Cartes* shews a Method of taking away the second Term of any Equation, and the Method is very well known, and in common Use. But there is one *D. T.* mentioned in the *Acta Eruditorum*,  
May



May 1683, which gives a general Analytical Method for taking away all the intermediate Terms of an Equation; which (he saith) was never done before, and was thought impossible by many.

TERMS of *Proportion*, in Mathematicks, are such Numbers, Letters or Quantities, as are compared one with another.

Thus if  $4 \cdot 8 :: 6 \cdot 12$  then  $a, b, c, d$ , or 4, 8, 6, 12, are called the Terms; of which  $a$  is called the first Term,  $b$  the second Term, &c.  $a$  and  $c$  are called the two Antecedents, and  $b$  and  $d$  the two Consequents.

TERRA *Damnata*. See *Earth*.

TERRA *extendenda*, is a Writ directed to the Escheator, &c. willing him to enquire and find out the true Yearly Value of any Land, &c. by the Oath of Twelve Men, and to certify the Extent into the *Chancery*, &c.

TERRAQUEOUS, in Geography, signifies the Globe of Earth and Water, as they both together constitute one Spherical Body.

TERRÆ *Testamentales*; Lands that were held free from *Feodal Services*, in *Allodio*, in Soccage, descendable to all the Sons, and therefore called *Gavel-kind*, were deviseable by Will, and therefore called by this Name, *Terræ Testamentales*.

TERRE-PLAIN, in Fortification, is the Platform or Horizontal Surface of the Rampart lying level, only with a little Sloap on the outside for the Recoil of the Cannon.

It is terminated by the Parapet on that Side toward the Field, and by the *Inner Talus* on the other toward the Body of the Place.

TERRE-Tenant, is he who has the actual Possession of the Land, which otherwise is called *Occupation*,

Thus a Lord of a Manor hath a Free-holder, who letteth out his Free-hold to another to be Occupied.

This Occupier (having the actual Possession) is called *Terre-Tenant*.

TERELLA: When a Loadstone is turned into an exact Spherical Figure, and is placed so that its Poles and Equator, &c. do exactly correspond to the Poles and Equator of the World; it is called by *Gilbert* *μικρογρ*, or *Terella*, a little Earth; because it is a very just Representation of the Great Magnetical Globe which we inhabit.

It was believed that such a Terrella as this, if nicely poised and placed in a Meridian, like a Globe, would be turned about in 24 Hours, as the Earth is by the Magnetical Particles that pervade it; but this by plain Experience is found to be a Mistake.

TERRER, or *Terrier*, is a Book or Roll wherein the several Lands, either of a private Person, or of a Town, College, Church, &c. are described; and this should contain the Number of Acres, the Site, Boundaries, Tenants Names, &c.

TERRESTRIAL *Globe*. See *Globe*.

TERRESTRIAL *Line*. See *Line Terrestrial*.

TERRIS, *bonis & catallis rehabendis post purgationem*, is a Writ that lies for a Clerk, to recover his Lands, Goods or Chattels, formerly seized, after he hath cleared himself of that Felony, upon Suspicion whereof he was formerly Convicted, and delivered to his Ordinary to be purged.

TERRIS & *catallis teptis ultra debitum levatum*, is a Writ Judicial, for the restoring of Lands or Goods to a Debtor that is Distrained above the Quantity of a Debt.

TERRIS *Liberandis*, is a Writ that lies for a Man Convicted by Attaint, to bring the Record and Process before the King, and to take a Fine for his Imprisonment, to deliver him his Lands and Tenements again, and to release him of the *Strip* and *Waste*.

It is also a Writ for the Delivery of Lands to the Heir after Homage and Relief performed, or upon Security taken, that he shall perform them.

TERSION, is Wiping or Cleansing the outside of any Body.

TERSOR. See *Latissimus Dorfi*.

TERTIAN *Ague*, or Fever, is that which intermits intirely, and then returns again every third Day inclusively.

TERTIATE: To tertiate a great Gun, is to know the Thickness of the Metal at the Touch-hole, the Trunnions, and at the Muzzle; by which to judge of the Strength of a Gun, or whether it be well *Fortified* or not. This is usually done with a Pair of Calliper-Compasses; and if the Piece be *Home-bored*, the Diameter less by the Height divided by 2 is the Thickness at any Place.

TESSELLATA *Pavimenta*; were the Pavements in the Tents of the Roman Generals, a rich *Mosaick Work*, made of curious small square Marbles, Bricks, or Tiles, called *Tessellæ*, from the Form of *Dice*.

TEST, the same as the *Cuppel*, or Coppel, an Instrument used by Chymists and Refiners, to purify Gold or Silver. See *Cuppel*.

TESTACEOUS *Fishes*, are such whose strong and thick Shells are entire, and all of one piece; as the Oyster, Escollop, Cockle, &c. But those whose Shells are softer and thinner, and which are divided into distinct Joints, and composed of several Pieces, such as Lobsters, Crawfish, Crabs, &c. are called *Crustaceous Fishes*.

TESTAMENT, is the Last Will or Declaration of the Mind of a Person deceased; and is of two kinds, viz. *A Testament in Writing*, and *A Testament in Words*, which is called a *Nuncupative Testament*; which is, when a Man being Sick, and for fear lest Death, Want of Memory, or Speech, should come so suddenly upon him, that he should be prevented, if he stay'd, the Writing of his *Testament*, desires his Neighbours and Friends to be Witness of his Last Will, and then declares the same before them in Words, which after his Decease, is proved by Witnesses, and put in Writing by the Ordinary, and then stands in as good Force as if it had at the first, in the Life of the Testator, been put in Writing, except only for Lands, which are deviseable but by a *Testament* put in Writing in the Life of the Testator.

TESTATUM, is a Writ in Personal Actions, as if the Defendant cannot be arrested upon a *Capias* in the County where the Action is laid, but is returned *non est inventus* by the Sheriff.

The Writ shall be sent into any other County, where such Person is thought to have wherewith to satisfy; and is called a *Testatum*, because the Sheriff hath formerly testified, That the Defendant was not to be found in his Bayliwick.

TESTE, is a Word commonly used in the last Part of every Writ, wherein the Date is contained, which begins with these Words, *Teste meipso*, &c.

TESTES; the Testicles of a Male are justly reckoned among the Principal Parts, because they are necessary to the Conservation of the Species.



But before I proceed to an Anatomical Description of them, 'tis necessary to say something of the *Vasa Præparantia*, which prepare the Matter out of which the *Semen* in the Testicles is elaborated; as I shall afterwards describe the *Vasa Deferentia*, that so the Reader may have this great and wonderful *Apparatus* all before him at one View.

In Man, some of the *Vasa Præparantia* afford Matter for the *Semen*, as the *Arteriæ Spermaticæ*; others bring back again the Blood that is superfluous, to the making of the *Semen*, and to the Nourishment of the Testicles; and these are the *Venæ Spermaticæ*; and both these Arteries and Veins were formerly called *Vasa Præparantia*: Some make the *Semen*, as the Testicles; some convey it from thence to its Conservatory or Store-house, as the *Vasa Deferentia*: Some contain the *Semen* till the time of Copulation, and these are the *Vesiculæ Seminales*: Some discharge the *Semen* into the Matrix in Coition; this is done by the *Penis*; and some, lastly, moisten the Passage (*viz.* the *Urethra*) whereby the *Semen* issues, and those are the *Prostrates*. Of all which in Order. And first of the

*Vasa Præparantia*, which are said to prepare Matter for the *Semen*; these are of two sorts, *Arteries* and *Veins*.

The *Arteries* are two, and spring from the Trunk of the *Aorta*, commonly two Fingers breadth under the Emulgents, not from its Side, but out of its Fore-part; the right whereof climbing over the Trunk of the *Vena Cava*, runs obliquely to the Vein of that same Side; as also the left, marches to the Vein of that Side.

The *Veins* are also two. The right arises usually from the Trunk of the *Vena Cava*, a little below the Emulgent; the left from the Emulgent itself, for otherwise it must have gone over the *Aorta*, whereby it might have been in Danger of breaking; or rather, by the continual Pulse of the Artery, the Recourse of the Venal Blood might have been retarded.

Now both these Veins and Arteries, a little after their rise, meet, and are invested both in one Membrane, made of the *Peritonæum*, and then run streight through the Region of the Loins above the Muscles *Psoæ* on each side, and above the *Ureters*, as they go, bestowing little Slips here and there upon the *Peritonæum*, between whose Duplication they descend, and so arrive at its Processes. The Veins divide very often into many Branches, and by and by inosculate and unite again; but the Arteries go along by one Pipe only on each side; until within 3 or 4 Fingers Breadth of the Testicles, where each is divided into two Branches, the less whereof runs to the *Epididymis*, the larger to the Testicle; and as I said, they descended between the Membranes of the *Peritonæum*, so they pass into the *Scrotum* between them, not perforating the inner in the Processes, as in Dogs and other Creatures, wherein the Processes of the *Peritonæum* are hollow like a Quill; but in Man, the inner Membrane of the *Peritonæum* shuts the Hole, lest the Intestines by it fall into the *Scrotum*; of which there is greater danger in him, (and we see it often happen) because of his going upright. But to return to the *Vasa Præparantia*.

It has been generally taught, That there are divers Inosculationes of the Arteries with the Veins in their Passage, whereby the Venal and Arterial Blood are mixed; but this Opinion is now explod-

ded, for that granting the Circulation of the Blood, it is impossible: For the Blood in the Arteries descends towards the Testicles, and that in the Veins ascends from them; so that if these two Vessels should open one into another, the Blood in one of them must needs be driven back, or else stagnating, distend and break the Vessels. But the Truth is, the Blood both for Nourishment of the Testicles, and the making of the *Semen*, flows down by the Arteries only, and that in an even undivided Course, without any of those Windings and Twirlings like the Tendrels of Veins talk'd so much of (as the Curious *de Graef*, from his own frequent Inspection, testifies) and the Veins bring back from the Testicles what of the Blood remains from their Nourishment and making of the *Semen*; and these, indeed, come out of their inmost Membrane, by almost innumerable Roots, by which they imbibe the said Blood, and are most admirably interwoven and inosculated one with another, till about Four or Five Fingers Breadth above the Testicle, which Space is called *Corpus Pyramidale*, *Plexus Pampiniformis*, or *Varicosus*.

But these Veins are so far from preparing the *Semen*, as that they only bring back what was superfluous from the making of it. And, indeed, the *Arteries* in Men, do no more merit the Name of *Præparantes*, in respect to the *Semen*, than the *Gullet* in respect to the Chyle, or the *Ductus Thoracicus Chyliferous* in regard to the Blood; for there Blood acquires no sensible Alteration till it come to the Testicles themselves. But, however, we continue the old Names, declaring only against the Reason of them. And we will only note two Things more.

First, That the Spermatick Veins have from their Rise to their End, several *Valves* which open upwards, and so suffer the Blood to ascend towards the *Cava*, but not to slide back again.

2dly, That tho' the Spermatick Arteries go such a direct Course in Men, as has been said; yet in Brutes they are more complicated and twisted with the *Veins*, but without any *Anastomoses* of one into the other.

These *Vasa Præparantia*, thus described, proceed we to the *Testes*.

These have Arteries and Veins (as is said above) from the former *Vasa Præparantia*, which some have thought to reach only to the inmost Coat, called *Tunica albuginea*, because they are not conspicuous in the inner Substance of the Testicles. But tho' this may be true of the Veins which only receive the superfluous Arterial Blood, and have nothing to do with the *Semen*, yet it is not true of the Arteries, namely, of the most numerous Branches of them. Indeed Blood is seldom seen in the Substance of the Testicles; but that comes to pass by reason that the Arterial Blood presently loses its Colour, and by the Semenifick Faculty of the *Testes* is turned into *Semen*, which being whitish, of the same Colour with the Vessels, makes them indiscernible; yet in those Men that have died of languishing Diseases, and whose *Testes* have their Faculty impair'd,

*Diemerbroeck* affirms, That he has oft discovered sanguiferous Vessels in the inmost Parts of the *Testes*, and has shewed them to many in the Publick Anatomical Theatre.



As for *Nerves*, Dr. *Willis* says, he could never observe more to go to them than one from a Vertebral Pair, and that too was most of it spent upon the Muscle *Cremaster*.

*Diemerbroeck* agrees to one Nerve, but thinks it proceeds from the sixth Pair (which is Dr. *Willis*'s *Intercostal*, as distinguished from that commonly called the *Sixth*, but his *Eighth*.) Others will have Branches from both these Nerves to go to them. Concerning the Use of these Nerves there is great Controversy. Dr. *Glisson*, *Wharton*, &c. will have them to convey a *Succus Genitalis*, which makes the greatest part of the *Semen*. Dr. *Willis*, as he denies (in *Cerebri Anatom. cap. 27.*) any *Succus Nutritius* to be conveyed by the Nerves to other Parts; so that any *Succus Genitalis* is brought by them hither, but only Animal Spirits.

And whereas, to strengthen the former Opinion, 'tis usually objected, That the *Semen* must needs consist of a Nervous Juice, and plenty of Spirits brought from the Brain, because of the great Debility and Enervation that is induced upon the Brain and Nerves, by the too great Expence of it. He thus answers, That this comes to pass, because after great Profusions of the *Semen*, for the restoration of the same Humour (whereof Nature is more solicitous, than for the benefit of the Individual) a greater tribute of Spirituous Liquor is required from the Blood, to be bestowed on the *Testicles*. Wherefore the Brain being defrauded of a due Income and Afflux of the said Spirituous Liquor, languishes; and so the Animal Spirits failing in the Fountain, the whole Nervous System becomes depauperated and flaggy. Whereto may be added, That also the Animal Spirits themselves that actuate the *Prostates*, being derived from the Spinal Marrow, are much wasted by Venereal Acts: So that for this Reason besides, the Loins are enervated.

In this Answer *Bartholin* acquiesces: And *de Graef*, *Diemerbroeck*, &c. confess, indeed, That the Spirituous Arterial Blood is impregnated with Animal Spirits from the Nerves; but affirm, That the Matter out of which the *Semen* is elaborated, is only the said Blood; and to these we subscribe.

*Lympheducts*, they have also a rising from betwixt their Coats, and ascending upwards into the *Abdomen* with the *Vasa Deferentia*. These have many Valves looking upwards, which hinder any thing from descending by them to the *Testes*, but permit the *Lympha* to ascend, which they convey into the Chyliferous Vessels. *Malpighi* thinks it probable that some fall is derived to the Seminary Vessels for the Generation of the *Semen*, or at least to be mixed with it, seeing most Creatures grow the fatter upon being Castrated.

They have two sorts of Coats, Proper, and Common. The Common invest both the *Testes*, (constituting the *Scrotum*) and are two: The outermost consists of the *Cuticula* and true Skin (here thinner than in other Places.) It is soft and wrinkled, and is generally affirmed by Anatomists to be without Fat. On the outside it has a Suture or Seam that runs lengthways of the *Scrotum*, and divides it into the Right and Left side. The other, or inner common Coat, is a carnosus Membrane, which seems to be Muscular, because of the Power it has to contract and wrinkle itself. It is called *δάρσις*, and adheres to the proper Coat next under it (called *Vaginalis*) by many Membranous Fibres,

This is the common Account of this Part that all Anatomists have usually given; but lately Dr. *Frid. Ruysch* affirms, That it has the *Membrana adiposa* also under the *Carnosa*; or rather, that the *Carnosa* is fatty (on the inside) as it is in other Parts of the Body. And besides, he says, that in the *Scrotum* there is a *Septum* within, dividing it into two Parts; of which, says he, you have nothing in *Vesalius*, *Bartholin*, *de Graef*, &c. Men that have otherwise deserved very well of Anatomy: And what wonder, seeing all things about the *Scrotum* of one newly dead, are so slippery and moveable, that the true Constitution of the *Septum* can hardly appear. Wherefore, if any one would demonstrate this, the *Scrotum* is to be blown up, and to be cut open after 'tis dried, by which means the *Septum* yields itself to view, and has an Infinity of Blood-vessels running through it.

Thus he. This *Septum*, *Verheyen* says, is the same Substance with the carnosus Membrane above described, from which it seems to arise in the same manner as the *Mediastinum* from the *Pleura*. To each side of it the *Testes* are firmly knit, by means of their outer Proper Coat, and its Use is partly to sustain the *Testes*, and to hinder them from hitting against one another; and partly to help the carnosus Membrane to wrinkle, and purse up the *Scrotum*.

The proper Coats are also two, and these enclose each Testicle apart. The outer is called *Elitroides*, or *Vaginalis*; because it contains the Testicle as a Sheath. It is a thick and strong Membrane, having many Veins; in the outside it is uneven, by Reason of the Fibres, by which it is knit to the *Dartos* and *Septum*; but in the inner side it is smooth. This is nothing else but the Production of the *Peritonæum*, even as the *Scrotum* is of the Skin and *Membrana carnosus* of the *Abdomen*. Into this Coat is inserted the Muscle *Cremaster*, of which presently.

The inmost is *νευρώδης*, the Nervous Membrane, called *Albuginea*, from its Colour. It is white, thick and strong, framed of the external Tunicle of the *Vasa præparantia*: It immediately enwraps the Testicles, towards which it is rough, but on the outside next the *Vaginalis*, it is smooth; and between these two, the Water is contained in an *Hernia aquosa*.

Into the outer of the proper Membranes (as was said) is inserted the Muscle *Cremaster*. These Muscles (to each Testicle one) have their Rise from the *Ossa Pubis*; and almost encompassing round the Processes of the *Peritonæum*, descend with them to the *Testicles*; where their Carnous Fibres run thro' the whole length of this same *Tunica Vaginalis*, especially in its lower Part, and so keep the Testicles suspended, from whence they have their Name (from *ὑψιμαζω* *Suspendo*) from their spreading themselves thus on the outer side of the outer proper Coat.

*Riolanus* reckons them for a third proper Coat, called in *Erythroides*; and because of its Carnous Fibres, it makes the *Vaginalis* look Red: Such as take it not for a distinct Coat, do give the Name of *Erythroides* also to the *Vaginalis*, calling it by either Name indifferently. These Muscles pull up the Testicles in the Act of Generation, that the Vessels being slackened, may the more readily void the *Semen*; and at other times they help to sustain their Weight.



The Muscles in Sickness and old Age become flaggy, and so the *Scrotum* relaxing itself, the Testicles hang low.

Upon the *Testes*, as yet clad with the *Tunica Albuginea*, are fixed the *Epididymidæ* (called also *Parastatæ*, *Standers by* or *Assistants*) enwrapped in the same Coat with the Spermatick Vessels; they adhere closer to the Testicles at their ends, than in the midst.

*De Graef* defines them to be *Vessels making with their various Windings, that Body that is fixed on the Back of the Testicles.*

To find out their Substance, he directs us thus.

First, Take off the Membrane that encompasses them, and knits them to the Testicles, and then there will appear many Windings, which with the Edge of a Knife may, without hurting the Vessels, be so easily separated from one another, that they may be drawn out into a Length like a Thing folded; for they are only folded from one side to the other, and are kept in that site, by the Membrane received from the *Tunica Albuginea* (or Spermatick Vessels.)

But when you have unravelled half of them, you must cut another very thin Membrane, and then you will see other Vessels lie just like these, and may be unloosed like them: And the whole being unravelled, the thicker they are by how much further from their Origin, which is implanted into the upper Part of the Testicle, by six or seven Ramifications; which having run so far, as where they join into one Duct, make it as thick as a small Thread; and this by Degrees so thickens, that being encreased like a Chord, it makes the *Vas Deferens*.

So that (saith he) it is clear from thence:

First, That the *Testes* do not differ from the *Epididymidæ* (or *Parastatæ*) saving that those consist of divers Ducts; but these, after their six or seven Roots that arise out of the Testicle are united (which they are in a short Space) but of one, only a little thicker.

Secondly, That the *Epididymidæ* differ not from the *Vasa deferentia*, saving that the former go by a serpentine winding Passage, and these by a streight; and that those are a little softer and narrower.

Out of the *Epididymidæ* at their smaller End, arise two *Vasa deferentia*, otherwise called *Ejaculatoria*, as if in the *Coitu*, the *Semen* were ejaculated from the Testes through them; which indeed was the common Opinion, 'till the *Vesiculæ seminales* were found out, which are now known to be the Store-houses of the *Semen*, and not the *Testes*; so that the *Vasa deferentia* deserve not the Name of *Ejaculatoria*, except it be that Part of them which reaches from the *Vesiculæ seminales* to the *Prostatæ*, through which indeed, the *Semen* is ejaculated in *Coitu*.

They are white, hardish Bodies, like a pretty large Nerve, with a Cavity not very discernible, but which may be made so, if one open one of them six or seven Fingers breadth above the Testicle, and then either blow into it with a small Pipe, or squirt some Liquor into it, with a Syringe towards the *Epididymidæ*: Or if you either blow or squirt Liquor by a Syringe, the other way towards

the *Vesiculæ seminales*, the said *Vesiculæ* will be distended.

Now from the *Epididymidæ* these *Vasa deferentia* ascend, and pass out of the *Scrotum* into the *Abdomen*, the same way by which the *Vasa præparantia* came down, viz. by the Process of the *Peritonæum*. When they are entered the *Abdomen*, they are carried presently over the *Ureters*, and turning back again, they pass to the backside of the Bladder; between which, and the *Intestinum rectum*, they march at a little Distance the one from the other, 'till about the Neck of the Bladder, where they grow wider and thicker; and then just as they are going to meet, their sides open into the *Vesiculæ seminales*, in which they deposite the *Semen*; but not terminating here, but coming close together, and growing smaller and smaller, they go on and end at the *Urethra*, betwixt the *Prostatæ*. At their ending *Verheyen* (with some other) affirms there is a little *Septum* between them, with a Caruncle (which they call a *Cock's Head*) to hinder the *Semen* that comes out at one Orifice, to go in by the other; and the two Orifices by which the *Semen* is ejaculated into the *Urethra*, are called the *Eyes of the Cock's Head*.

These *Vesiculæ* are little Cells like those in a Pomegranate, or something like a Bunch of Grapes: *De Graef* compares them to the Guts of a little Bird diversly contorted. They consist of one thin Membrane, through which some small Twigs of both Veins, Arteries and Nerves run. They are about three Fingers-breadth long, and one broad; but in some Places broader, some narrower, as they run in and out. They are two (one for each *Vas deferens*) divided from one another by a little Interstice; and they do so severally by a peculiar Passage emit the *Semen* contained in them into the *Urethra*. They are very anfractuous and winding, and (as was said) consist of many little Cells, that they should not pour out all the *Semen* contained in them in one Act of Coition, but might retain it for several: They have no Communication one with another, not even in their very opening into the *Urethra*; but the *Semen* is brought to the *Vesiculæ seminalis* on the right side, by the right *Vas deferens*, issues by its proper passage into the *Urethra*; and that which is brought to the left likewise; so that if by any accident the *Vesiculæ*, or one side be burst, or cut (as in cutting for the Stone they generally are) yet those on the other being entire, may still suffice for Generation: Now when the Seed is emitted out of these *Vesiculæ* in the Act of Coition, it passes out the same way it came in, which in this Case may easily be (tho' otherwise it be unusual, there should be a contrary Motion in the same Vessel) for as it comes in from the *Vasa deferentia*, it drills along gently without any force; but in *Coitu*, when the Muscles in the *Penis*, and all the bordering Parts are much tumified, it is expressed, or ejaculated out of them with some Violence, and passing along their Neck (which is a Continuation of the *Vasa deferentia*) ouzes through a Caruncle into the *Urethra*; for there is one Place as a Valve before the Orifice of each of them, partly to hinder the coming of the Urine into them, partly to hinder the involuntary Effusion of the *Semen*.

Now, tho' naturally, the little Holes through which the *Semen* passes out of the Necks of the *Vesiculæ* into the *Urethra*, be almost imperceptible; yet if they be either eroded by the Acrimony of the *Semen*



*Semen* (such Acrimony as is contracted by impure Embraces, or in Claps as they call them;) or if of themselves they be debilitated and so become more lax (as sometimes happens to old and impotent Men that meddle too much) then there happens a *Gonorrhæa*, or continual Efflux of the *Semen*. And so *Vesalius* and *Spigelius* have observed them much dilated, in dissecting such as have died with a *Gonorrhæa* upon them.

The *Prostatæ* are placed near the *Vesiculæ seminales*; *De Graef* calls them *Corpus glandulosum*, supposing them to be one Body, and only divided by the common Ducts of the *Vesiculæ seminales*, and *Vasa deferentia* coming through the midst of it.

They are of a white spongy, and glandulous Substance, about as big as a small Wallnut, encompassed with a strong and fibrous Membrane from the Bladder, to the beginning of whose Neck they are joined at the Root of the *Penis*: In shape they come nearer to an Oval, save that on their upper and lower sides, they are a little depressed, and in that end by which the *Vasa deferentia* enter, they are something hollow like a Tunnel. The Sphincter-Muscle of the Bladder encompasses them so that for so far as they cover the Neck of the Bladder, the *Sphincter* touches it not, they coming between. They have all sorts of Vessels, which run mostly on the outer side; in their inner Part, they have ten or more small Ducts, which all unload themselves into the *Urethra*, by the sides of the Caruncle, through which the *Semen* passes from the *Vesiculæ* into the *Urethra*, and themselves have each one a small one to stop its Orifice, lest the Liquor that is contained in the *Prostatæ* should continually flow out, or the Urine should flow in: And these small Ducts, I suppose, are continued from those *Vesiculæ*, which appear in the *Prostates* of those that die (any way) suddenly after Coition: For in such the spongy part of the *Prostatæ* is very turgid with a serous Liquor; and in their inner part may be found the same *Vesiculæ*, like to *Hydatides*, which if you press upon, they will discharge themselves in the abovesaid Ducts.

What the Liquor they contain should be, or what is their Use, there is a great Variety of Opinions: Some think that the *Semen*, that flows from the Testicles, is further elaborated here: But that cannot be; for that the *Vasa deferentia* deposite nothing in them, but all into the *Vesiculæ Seminales*. Others think, that from the Blood there is separated in them an acrimonious, and serous Humour, which serves for procuring the Titillation in Coitu. As to this, *De Graef* appeals to the Taste of it, which has nothing of an Acrimony.

*Dr. Wharton* thinks they make a particular kind of *Semen*, as the Testicles do another, and the *Vesiculæ Seminales* a Third. That these last make a *Semen* different from that made in the Testicles, is grounded on a Mistake in Anatomy, viz. That the *Vasa deferentia* have no communication with the *Vesiculæ*; whereas they apparently open into them, and deposite in them all the *Semen* they contain: That the *Prostatæ* make a peculiar Sort, he endeavours to prove, because castrated Animals emit some *Semen*. But that is but precarious; for tho' they emit something, 'tis not necessary it should be any true *Semen*: Or if it be, it may well be supposed to proceed from the *Vesiculæ Seminales*, that were full when the Animal was castrated. For, for this Reason it has been observed, that presently after the Castration they have sometimes got the

Female with Young, but not afterwards, when that Stock was spent. *Bartholin*, with many others, thinks they make an oily, slippery, and fatty Humour, which is pressed out, as there is need, to besmear the *Urethra*, whereby to defend it from the Acrimony of the *Semen*, and Urine, and lest it should dry up. This Humour *Malpighius* thinks to be conveyed hither by the *Ductus adiposi*, and quotes *Severinus*, affirming that he has observed a plain Vessel in the Fat of the Kidneys, tending to the Spermatick Vessels. He ascribes the same Use to it as *Bartholin*, &c. *Diemerbroeck* confesses, that 'tis necessary the inside of the *Urethra* should be kept moist, and slippery, but thinks that is done here, as in the Bladder, Intestines, and many other places, from some mucid Part of the Nourishment of the *Urethra* itself, and concludes that the *Vasa deferentia* deposite not all the *Semen* into the *Vesiculæ seminales*, but carry a smaller Part to these *Prostatæ*.

*De Graef* denies, that the *Vasa deferentia* convey any thing to them, or have any Communication with them; and therefore believes, that the Humour that is separated in the *Corpus glandulosum* (as he calls the *Prostatæ*) serves for a *Menstruum*, or *Vehicle* of the *Semen*, which flowing but in small Quantities, through small Pores into the *Urethra*; it was necessary, that this Humour should be mixt with it, that it might the better reach the Womb. Whatever this Humour be, it is squeezed out partly by the Intumescence and Erection of the *Penis*; and partly by the Compression of the Sphincter of the Bladder, that girds the *Prostatæ* about.

These *Prostates* are often (at least partly) the Seat of the *Gonorrhæa*; and the Humour that they contain, is that which is shed.

*TESTES Cerebri*, are the two lower and lesser Protuberances of the Brain, so called from the likeness they have to Testicles. These with the *Nates* which lie about them, and the *Protuberantiae Striatæ*, are the Origin of the *Medulla oblongata*. The Uses of these *Testes* you may see in *Willis's Anatomy of the Brain*; but they seem but conjectural.

*TESTONS*, or, as we commonly call them, *Testors*, from their having an Head (*Testa*) upon them, were in 34 H. 8. coined either here, or in France; and *Spelman* saith, their value in France was 18 d. and he doth not know but that they might go for as much here. He saith it was Brass, and covered over with Silver (which perhaps gave rise to the Iniquity of Plating Money.) They went with us in H. 8th's Time for 12 d. but in *Edw.* 6th's they sunk down to 9 d. and then to 6 d. (which still retains the Name of a *Testor*.) In *Anno Dom.* 1559, they fell to 4 d. ob. and *Stow* saith, there was a second sort of *Testons*, which in that Year were cried down to 2 d. q. and that there was a third sort, which were made unpassable at any rate. *vid Chron. Precios.* pag. 41.

*TESTUDO*, is a soft large Swelling, or not very hard, in the Head, broad, in Form of an Arch-Dome, or the Back of a Tortoise, from which resemblance it takes its Name. At the Beginning it grows like a Chest-nut, afterwards like an Egg, wherein is contained a soft Matter clothed with a certain Tunick (whence some refer this sort of Tumour to *Meliceræ*, which see) which sticks so close to the Skull, that many times it infects and corrupts it. *Blanchard*.



**TETANUS**, [*τετανος*, Gr.] or *Tetanon*, is a Contraction, whereby a Limb grows rigid and inflexible. The Cause of it is sometimes a Relaxation or Palsy in some other Muscles, which when they are relaxed, the opposite Muscles act too strongly; so that they draw the Part wholly to themselves, which ought to consist, as it were, in an *Æquilibrium* betwixt both: Yet sometimes such a permanent Contraction may proceed from the Tendons being loaded and obstructed with serous Matter, which thereupon grow rigid and stiff.

This Distemper is frequent in the Scurvy, so that the Patient can extend neither Joint nor Limb. The Tendons in the Back are sometimes contracted into a round globular Form, which, by Reason of such an Afflux of Humours upon them, draw the Bones out of their due Places, and cause an Hunched Back, or a Stooping or Bending of it. It is usually distinguished into *Universal*; of which there are three Sorts, *Emprosthotonos*, *Opisthotonos*, and *Tetanos*, properly so called, and *Particular*, which respects a certain Member, or a particular Joint. *Blanchard*.

**TETRACHORD**, [*τετραχορδον*, Gr.] in Musick, is a Concord or Interval of 3 *Tones*.

The *Tetrachord* of the Ancients, was a Rank of four Strings, accounting the *Tetrachord* for one Tone, as it is often taken in Musick.

**TTRACTYS** *Pythagorick*, was a Point, Line, Surface and Body.

**TETRADIAPASON**, a Quadruple Diapason; is a Musical Chord, otherwise called a Quadruple Eighth, or Nine and Twentieth.

**TETRAGONIAS**, [of *τετράγωνος*, Gr.] a Comet, whose Head is of a Quadrangular Figure, and its Tail or Train, long, thick and uniform, and does not differ much from the Meteor called *Trabs*.

**TETRAGONISM**, with some foreign Writers, is the same as the Quadrature of the Circle.

**TETRAGONISTICK** [of *τετράγωνος*, Gr.] *Calculus*, is the same with the summatory or differential Calculus of *Leibnitz*; which see.

**TETRAGONUS**. See *Quadratus Genæ*.

**TETRAHEDRON** [of *τετραέδρον*, Gr.] See *Regular Bodies*. N.B. These following Figures being cut in Paste-board, and folded up, will either of them represent the *Tetrahedron*.



**TETRAPETALOUS** [of *τετρας* four, and *πέταλον*, Gr. a Flower Leaf] *Flower*, of a Plant, is that which consists of but four single, coloured Leaves (which the Botanists call *Petala*) set round the *Stylus* to compose the Flower.

Plants having a Tetrapetalous Flower, constitute a distinct Kind, and by Mr. Ray are divided into,

1. Such as have an uniform Tetrapetalous Flower, and their Seed-Vessels a little oblongish, which therefore he calls *Siliquose*.

As the *Keiri* or *Leucoium Luteum*, and the other common *Leucoium*; the *Dentaria*, the *Leucoium Siliquosum*, *Alysson*, *Viola Lunar*, *Paronychia*,

*Hesperis*, *Alliaria*, *Rapa*, *Napus*, *Snapis*, *Rapissimum*, *Eruca spuria*, *Erysimum*, *Cardamine*, *Turritis*, *Pilosella Siliquosa*, and the *Raphanus Rusticanus* and *Aquaticus*.

2. Such as have their Seed-case or Vessel shorter, which therefore for Distinction he calls *Capfulatæ* and *Siliculosæ*; as the *Myagrum*, *Draba*, *Leucoium*, *Siliqua subrotunda*, *Cochlearia*, *Nasturtium*, *Lepidium vulgare*; *Thlaspi*, *Brasica marina*, *Glastum*, *Eruca marina*, &c.

3. Such as have a kind of, or seeming Tetrapetalous Flower, i. e. a Monopetalous one divided deeply into 4 Partitions, and these he calls *Anomalous*; as the *Papaver*, *Agremone*, *Veronica*, *Tithymallus*, *Plantago*, *Coronopus*, *Psyllium*, *Lysimachia Siliquosa*, *Alfne spuria*, &c.

**TETRAPHARMACUM**, [*τετραφάρμακον*, Gr.] is a Medicine consisting of four Ingredients, as *Unguentum Basilicum*.

**TETRAPTOTES**, [of *τετρας* and *πῶσις*, Gr. a Case] are in Grammar, such defective Nouns, as have only four Cases; as, *Plus*, which wants the *Dative* and *Vocative* Singular.

**TETRASTYLE**, [*τετράστυλον* of *τετρας* and *στυλος*, Gr. a Column] in Architecture, is a Building which hath four Columns in the Faces before and behind.

**TEXTURE**. The Texture of any Natural Body, is that peculiar Disposition of its constituent Particles, and making it have such a Form, or be of such a Nature, or be endowed with such Qualities.

**THALAMI** *Nervorum Opticorum*, are two Prominences of the lateral Ventricles of the *Cerebrum*, so called, because the Optick Nerves rise out of them. They are Medullary without, but a little Cineritious within. They are of an oblong Figure.

**THANE**, anciently in the *Saxons* Time, was a military Servant; the King's Thane was a *Saxon* Lord or Nobleman: but after the Conquest the Word came to be used sometimes to denote all Persons of Superior Degree.

**THAUGHTS**, or *Thoughts*, are the Benches on which the Rowers sit in a Boat to Row.

**THEATER**, in *Italian Architecture*, an Assemblage of several Buildings, which, by a happy Disposition and Elevation, represents an agreeable Scene to the Eye.

**THELONIA** *rationabili habendo pro Dominis habentibus Dominica Regis ad firmam*, is a Writ that lies for him that hath of the King's Demesne in Fee-farm, to recover reasonable *Toll* of the King's Tenants there, if his Demesne have been accustomed to be *Tolled*.

**THELONIUM**, or *Breve essendi quieti de Thelonio*, is a Writ lying for the Citizens of any City, or Burghesses of any Town, that have a Charter or Prescription to free them from *Toll*, against the Officers of any Town or Market, who would constrain them to pay *Toll* of their Merchandize, contrary to the said Grant or Prescription.

**THENOR**, or *Tenor*, according to some, is the Name of an abducent Muscle, which draws the Thumb from the Fore-finger.

**THEODOLITE**, [of *θεοδωλει*, Gr. to view,] is an Instrument used in *Surveying*, and Taking of Heights and Distances.

It consisteth of several Parts: As,



1. *A Circle of Brass*, divided into four Quadrants, representing the four Cardinal Points of the Compass, *East, West, North* and *South*, and noted with the Letters, N. S. W. E.

Each of these *Quadrants* is divided into 90 Degrees, and subdivided as the Largeness of the Instrument will permit, commonly by *Diagonals*.

These four Quadrants are to be numbred by 10, 20, 30, &c. both ways beginning at the *North* and *South* Points, and ending with 90, at the *East* and *West* Points.

2. *A Box and Needle*, so conveniently contrived to stand upon the Centre of the Circle, upon which Centre, the *Instrument*, the *Index*, with its *Sights*, must be made to turn about, and yet both the *Instrument*, and the *Box and Needle* remain firm. At the the Bottom of the *Box* there must be a *Card* or *Mariner's Compass* fixed, answerable to the Letters E. W. N. S. upon the *Instrument*.

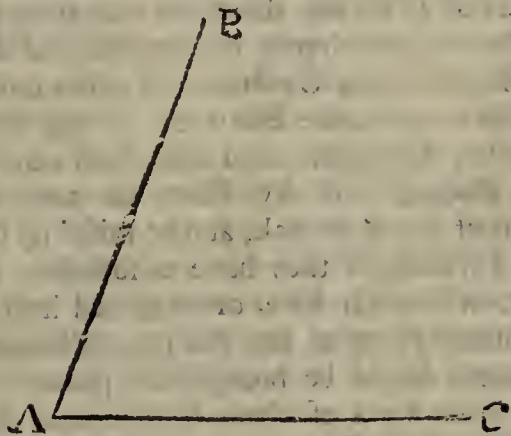
3. *A Socket* on the Back-side, (either Plain or with a *Ball*, which is much better) to be put upon the Head of a three-legged Staff.

4. *A Staff* to set the *Instrument* upon; the Neck at the Head whereof must be made to go into the *Socket* on the Backside of the *Instrument*.

Its Use is for taking *Heights* and *Distances*, as also taking of *Angles*, in Surveying of Land, &c.

To take the Quantity of an Angle by the Theodolite.

As suppose the Angle A, of a Field, two of whose Sides is AB or AC.



Place your Instrument in the Angle A, or as near as possible, and let Marks be set up near B and C, so far off the Hedges as your Instrument at A stands (which yet is not necessary) then turn the Instrument about, till through the fixed Sights you see the Mark at B, there screw it fast; next turn the moveable Index, till through the Sights thereof you see the Mark at C, then the Degrees upon the Limb cut by the Index, gives the Angle BAC.

THEOREM, [θεωρημα of θεωρεω, Gr. to contemplate,] is a Speculative Proportion, demonstrating the Properties of any Subject: This is either,

1. *Universal*, which extends universally to any Quantity without Restriction; as, *That the Rectangle of the Sum and Difference of any two Quantities, is equal to the Difference of their Squares.*

2. *Particular*, when it extends only to a particular Quantity.

3. *Negative*, which demonstrates the Impossibility of an Assertion; as, *That the Sum of two Biquadrate Numbers cannot make a Square.*

4. *Local*, which relates to a Surface; as, *That Triangles of the same Base and Altitude are equal.*

5. *A plain Theorem*, is that which relates to either a Rectilineal Surface, or to one terminated by the Circumference of a Circle; as, *That all Angles in the same Segment are equal.*

6. *A solid Theorem*, is that which treats about a Space terminated by a solid Line; that is, by any of the three Conick Sections; as, *If a Right Line cut two Asymptotick Parabola's, its two Parts terminated by them shall be equal.*

7. *A Reciprocal Theorem*, is one whose Converse is true; as, *That if a Triangle have two equal Sides, it must have two equal Angles.* The Converse of which is true, *That if it have two equal Angles, it must have two equal Sides.*

THEORETICK, } [θεωρητικὸς of θεωρεω, Gr. to contemplate] relating  
THEORETICAL, }  
THEORICK, } to Theory, or terminating in Speculation, in Opposition to Practical.

THEORETICKS, [θεωρητικοί, Gr.] a peculiar Appellation given to an antient Set of Physicians.

THEORETICAL Astronomy, is that Part of Astronomy that considers the true Structure and Disposition of the Heavens and heavenly Bodies, and accounts for their various Phænomena therefrom.

THEORY, [θεωρία of θεωρεω, Gr. to contemplate] a Doctrine terminating in the sole Speculation or Consideration of its Subject, without any View to the Practice or Application of it.

THEORIES of the Planets, in Astronomy, &c. are Hypotheses.

THERAPEUTICA, [θεραπευτικὴ of θεραπεύειν, Gr. to heal,] is that Part of Physick, which delivers the Method of Healing.

THERIOMA, [θερίωμα, Gr.] is a wild cruel Ulcer, like Carcinoma; which see. Blanchard.

THERMÆ, are the Bath or other Medicinal Waters, which are Hot. 'Tis most probable, as Dr. Woodward well observes, (Nat. Hist. of the Earth, p. 144.) That these do not owe their Heat to any Colluctation or Effervescence of the Minerals in them, but to the subterranean Heat or Fire, which communicates with them by some Spiracle or Canal, by which a greater Quantity of Heat is derived thither, than to ordinary Springs. Tho' Mr. Charas hath lately revived the former Opinion. Vid. Memoirs Mathemat. & de Physique, A.D. 1692.

THERMANTICA, [θερμαντικὰ of θερμαίνω, Gr. to warm] are healing Medicines.

THERMOSCOPE, [of θερμὸν, Gr. Warmth, and σκόπεω of σκέπτομαι, Gr.] or Thermometer, is a Philosophical Instrument, usually made of Glass, filled with tinged Spirit of Wine, or some other proper Liquor; and designed to measure, or estimate the Heat and Cold of any particular Place; or of the same Place in different Seasons, and at different Times.



At the Bottom is a pretty large Ball filled with the Spirit or tinged Liquor, with a Stem rising, to about three or four Foot perpendicular. To adjust the Divisions, or Degrees of which, the Ball may be placed in Water, which is just beginning to freeze; and then noting the Height of the Spirit in the Stem, place against that O, and graduate it afterward, up and down, for Heat and Cold.

Dr. Hook, in order to adjust these Graduations with the greater Accuracy, hath contrived, and described an Instrument for that Purpose. See *Micrograph. Pag. 38.*

*The Way of filling Thermoscopes, or such other small Glass Tubes, with Spirit of Wine, or Water.*

Take the Ball of the Glass, and first warm it gently between your Hands, then Neal it very well (tho' gently before a good Fire) turning it round, that it may be equally warm, for without this Caution, you'll endanger breaking it. Then applying the Ball to the Flame of a Lamp or Candle, turning it about in it, heat it as hot as you can, without melting the Glass, and then speedily immersing the open End of the Pipe into a Vessel of that Liquor you intend to fill it withal, the Liquor will rise into it, and fill it very near full.

The Reason of which Ascent of the Liquor is, That the Air within the Ball and Tube, being expelled in great Measure by the Heat, or at least, rarified there to a very great Degree, the immersed open End of the Tube keeps off the Pressure of the Incumbent Atmosphere on that Part of the Liquor that the End of the Tube covers; but the Atmosphere presses on all other Parts of the Liquor in the open Vessel; and consequently (there being none, or but a very small Quantity of Air within the Tube to hinder it) forces by its Weight up into the Tube, till it gain an Equilibrium with the Pressure or Weight of the Air without.

If by this Method the Tube cannot be filled full enough, the rest may be supplied by a small Glass-Funnel, whose Shank must be drawn out exceeding slender, and inserted into the Orifice of the Tube; and then by blowing, you may force with your Breath the Spirit of Wine into the Tube, so as to fill it quite, or to what Degree you please.

Dr. Hook, in his *Micrographia*, hath an Engine for graduating Thermometers, to make them true Standards of Heat and Cold.

THIRD, in *Musick*, a Concord which results from a Mixture of two Sounds, containing an Interval of two Degrees.

THIRD Point, in *Architecture*, the Point of a Section in the Vertex of an Equilateral Triangle.

THLIPSIS, is a Compression of the Vessels in an Animal Body. *Blanchard.*

THORACICA *Inferior*, a Branch of the Subclavial Veins, spreading it self upon the Side of the Breasts by several Branches, which communicate by *Anastomosis* with the Branches of the *Azygos*, under the Muscles of the Breast.

THORACICA *Superior*, is a Branch of the Subclavial Veins, arising from the *Basilica*, and goes to the *Mammilla* and Muscles of the Breast.

THORAX, or *Medius Venter*, the Chest; is all the Cavity which is circumscribed above, by the Neck-bones; below, by the *Diaphragme*; before, by the Breast-bone; behind, by the Back-bone; on the Sides, by the Ribs: It is of an Oval Figure,

contains the Heart and Lungs, and is cover'd on the Inside with a Membrane called *Pleura*.

*Hippocrates* and *Aristotle* took all that Space from the Neck-bone, to the very Secrets, both the middle and lowermost Cavity, for the Thorax.

THORUS. See *Tore*.

THOUGHTS, or *Thaughts*, so the Seamen call the Seats or Benches, on which the Men sit down to row in a Boat.

THOWLES, are those Pines in the Gunnel of a Boat, between which the Men put their Oars when they row.

THRAVE of Corn, in most Parts of *England*, consists of four Shocks; and each Shock contains six Sheaves; but in some Places they reckon but twelve Sheaves to a *Thrave*.

THREE-LEGG'D-STAFF, is an Instrument consisting of Wooden Legs, made with Joints, to shut all together, and to take off in the middle, for the better Carriage; and on its Top is usually a Ball and Socket to support and adjust Instruments for Astronomy, Surveying, &c.

THRISMA, was an old Piece of Money of the Value of a Groat, or the third Part of a Shilling; being seemingly a Corruption from *Tremissis*, which was a *German* Coin, of the Value of Four-pence. Some will have it to be a Three Shilling Piece, but it seems a Mistake.

THROMBUS, [*θρῶμβος*, *Gr.*] is a Coagulation of Blood or Milk into Clots or Clusters. *Blanchard.*

THUNDER and Lightning. The *Phænomena* of this very common, but sometimes dreadful Meteor, are thus accounted for, and solved by Dr. Hooke, *Opera Posth.* p. 169.

The Atmosphere about the Earth abound with nitrous Particles of a spirituous Nature, which are every where carried along with it; besides which sort of Particles, there are also others raised up into the Air, which may be somewhat of the Nature of Sulphureous, Unctuous, or other combustible Bodies; as we see Spirit of Wine, Spirit of Turpentine, Camphire, and almost all other combustible Bodies, will by Heat be rarified into the Form of Air or Smoak, and be raised up into the Air. All which, if they have a sufficient Degree of Heat, will catch Fire, or be turned into Flame by the nitrous Parts of the Air; as Thousands of Experiments might be brought to prove. There are also other Sorts of these Sulphureous Steams, which arise from subterraneous and mineral Bodies; which, only by their coming to mix with the Nitre of the Air, tho' they have no sensible Heat in them, will so ferment and act one upon another, as to produce an actual Flame: Which is a Thing that hath been often found in Mines, and more especially if any Part of them be kindled, then the whole Train which is mingled with the contiguous Air, will immediately take fire, like a Train of Gun-powder, and run from one End of those Vapours to the other, be they ever so long; as I could prove by a Multitude of Relations from Coal-Mines, and several other Mines. The Accension of which Vapours is so sudden, and with such Violence and Swiftnes runs from one End to the other, as often to kill the Miners, blow up their Props, Turns, Stays, Houses, &c. and produceth as prodigious Effects, as if a vast Quantity of Gun-powder had been fired in the Mine. Now Lightning in the Air seems to be much



much of the same Nature; for the Air is continually furnished with spirituous nitrous Parts; and the Summer Heat, whenever extraordinary, raises up out of the Earth (and to this the subterranean Heat also is continually concurring) a great Quantity of sulphureous Vapours, which are of such a Nature, as that meeting with the Nitre of the Air, they work upon each other, and thereby begins a further Degree of Heat, which gradually encreases, till at last it arrive at a certain Pitch; and then they fall upon and work on one another, producing an actual Fire and Flame, which with wonderful Swiftneſs fires the whole Train, and so produces the Flash and Noiſe.

Dr. Wallis in *Philos. Trans.* N<sup>o</sup> 231. p. 655. ſaith, That Thunder and Lightning are ſo very like the Effects of fired Gun-powder, that we may reaſonably judge they proceed from the like Cauſes. Now the principal Ingredients in Gun-powder, are Nitre and Sulphur, (the Admiſſion of Charcoal being chiefly to keep the Parts ſeparate, for the better kindling of it.) So that if we ſuppoſe in the Air a convenient Mixture of *Nitrous* and *Sulphureous* Vapours, and thoſe by Accident to take fire, ſuch *Exploſion* may well follow with ſuch Noiſe and Light, as in the firing of Gun-powder; and being once kindled, it will run from Place to Place, as the Vapour leads it, like as in a Train of Gun-powder, with the like Effects.

This *Exploſion*, if high in the Air, and far from us, will do no Miſchief, or not conſiderable; like a Parcel of Gun-powder fired in the open Air, where nothing is near enough to be hurt by it. But if the *Exploſion* be near to us, or amongſt us, it may kill Men or Cattle, tear Trees, fire Gun-powder, break Houſes, or the like; as Gun-powder would do in all like Circumſtances. This *Nearneſs*, or *Farneſs*, may be eſtimated by the *Diſtance* of Time between ſeeing the Flash of Lightning, and hearing the Clap of the Thunder; for tho' in their Generation they be *Simultaneous*, yet Light moving faſter than Sound, they come to us ſucceſſively. I have obſerved, that commonly the Noiſe is about ſeven or eight Seconds after the Flash; but ſometimes 'tis much ſooner, in a Second or two, or leſs than that, juſt after the Flash; and then the *Exploſion* muſt needs be very near us, and even amongſt us. And in ſuch Caſes I have more than once preſaged the Expectation of Miſchief, and it hath proved accordingly.

Now that there is in Lightning a ſulphureous Vapour, is manifeſt from the ſulphureous Smell that attends it, and the ſultry Heat in the Air, which is commonly a Fore-runner of Lightning ſoon after. And that there is a *nitrous* Vapour in it, we may reaſonably judge, becauſe we do not know of any Body ſo liable to ſo ſudden and violent *Exploſion*.

As to the kindling of theſe Materials, in order to ſuch an *Exploſion*, I am told that a Mixture of Sulphur, and Filings of Steel, with the Admiſſion of a little Water, will not only produce a great Efferveſcence, but will of itſelf break forth into an actual Fire: I ſay a little Water, becauſe too much will hinder the Operation, or quench the Fire: And this I take to be the Cauſe of the *Bath-Waters*, and other hot Springs, where Steel and Sulphur cauſe a great Efferveſcence, but no Flame. So that there wants only ſome *Chalybeate*, or *Vitriolick* Vapour, (or ſomewhat equivalent) to pro-

duce the whole Effect (there being no want of Aqueous Matter in the Clouds.) And there is no Doubt, but that amongſt the various Effluvia from the Earth, there may be copious Supplies of Matter for ſuch Mixtures.

The ſame Account may alſo be given of *Ætna*; and other burning Mountains, where the Mixture of Iron and Sulphur may give a Flame; which is often attended with prodigious *Exploſions* and Earthquakes, from great Quantities of Nitre, as in Springing a Mine.

THYMUS, is a conglobate Glandule in the Throat, growing to the upper Part of the *Medaſtinum*, and ſeated between the Diviſions of the Subclavian Veins and Arteries; it is whitish, ſoft and ſpongy, and larger in Children, and in Women, than in Men. The Jugular Veins and Arteries paſs thro' the Gland as they go up the Neck, but this don't ſend any conſpicuous Twigs or Branches to it: Its Uſe ſeems to be to prop and ſtrengthen the Diviſions of the *Aorta* and *Cava*, and to defend them from being compreſſed by the *Claviculæ* when we ſtoop forwards, and perhaps in Infants in whom it is large, and conſiſts in 3 Glands, it may contribute towards the refining and depurating of the Chyle; and poſſibly it may hinder (as *Verheyen* thinks) any too haſty Mixture of the Chyle with the Blood in Children.

THYREO-STAPHYLINUS, is a Muſcle of the *Uvula*, ariſing fleſhy from the Edge of the upper Part of the *Cartilago Thyroides*, between the *Thyreopharyngæus* and the *Membrana Faucium*; from thence it aſcends ſtraight upwards, being much dilated as it approaches the *Uvula*, on the upper Side of which it is ſpread very broad. In Swallowing, when this Pair of Muſcles act, the *Foramina Narium* are in a great meaſure ſhut, to hinder the paſſing of any thing thro' into the Noſe, that is taken in at the Mouth. *Dowglas Mioga. Comp. Specim.*

THYROARYTÆNOIDES, is a Pair of large Muſcles, that proceed from the Cartilage, called *Scutiformis*, and extending themſelves forward to the Sides of the *Arytænoides*; the fourth and fifth Part of the *Larynx*, ſerve to contract, and cloſe the Opening of the *Larynx*.

THYREOIDEÆ Glandulæ, are two, of a viſcous, ſolid Subſtance, wonderfully adorned with Veſſels of all ſorts, and hard Membranes, almoſt of the Bigneſs and Shape of an Hen's Egg; ſituate at the lower Part of the *Larynx*, at the ſides of the Cartilages, called *Scutiformes*. Their Uſe ſeems to be to ſeparate a Liquor from the Lubrication of the *Larynx*, whereby the Voice is rendred firm, ſmooth and ſweet; and they contribute alſo to the Roundneſs of the Neck, by their filling up the empty Spaces about the *Larynx*.

THYROIDES, [*θυροειδής* of *θύρα* a Door, and *είδος*, Gr. Form,] is the Cartilage, called *Scutiformis*, of the *Larynx*: Alſo the Hole of the *Os Pubis*, is by ſome called by this Name. See *Scutiformis*.

THYRSUS, is a Word uſed by the Botaniſts, for the upright, and tapering Stalk: And 'tis often uſed for *Spica*, which is an Ear, or Blade of Corn.

TIBIA, the Leg, is the Part betwixt the Knee and the Ankle: It conſiſts of two Bones; one outward, called *Focile Minus*; another inward, and larger, which has uſurped the Name of the whole, and is called *Tibia*; others call it *Focile Major*, and *Canna Major*: The upper End has a Proceſs, which



which is received by a Cavity in the Thigh, and two oblong Cavities to admit the Heads of the Thigh-bone; the Depth of which Cavities is encreased by a Cartilage that is annexed thereunto by Ligaments: This Cartilage is moveable, soft, slippery, moistened with an unctuous Humour; thick in its Circumference, and smaller towards the Centre; whence it is called *Lunata*, made like an Half-moon; there are rugged sharp Ligaments before, which encrease the Lunary Cartilages: The fore Part, which is acute and long, is called *Spina*: There is below a prominent and gibbous Process in the inner Side, nigh the Foot, and is called *Malleolus Internus*, the inner Ankle-bone.

**TIBIALIS Anticus**, a Muscle of the *Tarsus*, so called from its Situation on the Fore-part of the *Tibia*: It's also by *Spigelius* called *Musculus Catenæ*, because when it is divided, the Patient is forced to use a Sling, to support the Foot in walking: Its Origination is fleshy from the lower Part of the superior Appendage of the *Tibia*, between the Prominence, where the great Tendon of all the extending Muscles of the Leg is inserted, and the Origination of the *Musculus Extensor magnus Digitorum Pedis*: It also continues a disgregated fleshy Origination, for near two Thirds of the superior Part of the said *Tibia*, externally lateral, next the *Fibula*; which composing a fleshy Belly, lessens it self in half its Progress, and growing into a strong, and somewhat round Tendon, descending obliquely over the inferior Part of the said *Tibia*; and under the Annular Ligament, is inserted to the inside of the *Os Cuneiforme Majus*, that sustains the *Os Metatarsus Pollicis*: This pulls the Foot upwards and forwards directly.

**TIBIALIS Posticus**, is a Muscle of the Foot, which being placed on the Back-part of the *Tibia*, is also called *Musculus Nauticus*, because Mariners chiefly use it in climbing up the Masts of their Ships. It lies partly under the *Flexor tertii internodii Pollicis*, which Muscle must be partly raised together with the *Flexor tertii internodii Digitorum Pedis*, before we can have a clear sight of it. It appears biventral, arising partly tendinous, and partly fleshy from the Superior and Back-part of the *Fibula*; as also from the Ligament that is contained between the said Bone and the *Tibia*; in near half its Progress it becomes less, and grows fleshy again, and making a strong round Tendon, which runs in a *Sinus*, on the Back-part of the lower Appendage of the *Tibia*, called the *Malleolus Internus*, under an Annular Ligament, and is inserted to the *Os Naviculare*, internally and laterally. This draws the Foot upwards and inwards.

**TICHONIAN Hypoth.** See *Tychonian*.

**TIDE**, the Word *Tide* signifies as well the Ebbing as the Flowing of the Sea; the former of which the Seamen call *Tide of Ebb*; the latter, *Tide of Flood*. A *Windward Tide*, is when the Tide runs against the Wind. A *Leeward Tide*, is when the Wind and Tide go both the same way; when the Tide runs very strong, they call it a *Tide-gate*. To *tide it over*, or *up* into any Place, is to go in with the Tide of Flood or Ebb, as long as that lasts, and then to stay at an Anchor all the Time the contrary *Tide* lasts, and then to set in again, when the same Tide returns. It's said to flow *Tide* and *Half-tide*, when the Tide runs three Hours (which is four Points of the Compass) in the *Offing*, longer than it doth by the Shore. By longer, they do not mean more Hours, for it al-

ways Ebbs and Flows six Hours, but if it be high Water a Shoar at Twelve a Clock, it will not be so in the *Offing* 'till Three, which is the Bound and Time for the running of a Half-tide. If it Ebbs and Flows more, they say, it runs Half-tide, and half Quarter, that is five Points; when they are to go into a Harbour over a Bar or Sand, their Word is, that they will bring the Tide with them; that is, they will come in with the Flood, that so they may get over the Bar or Sand safely.

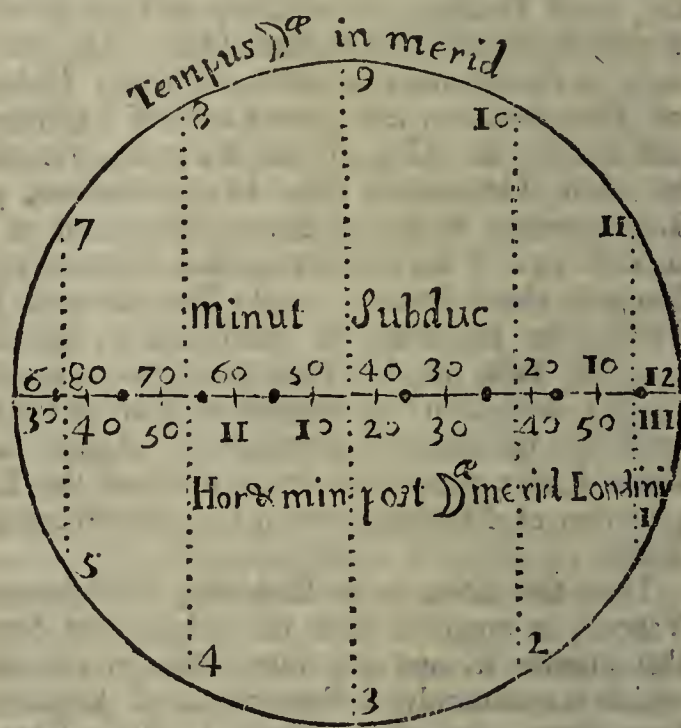
**TIDES.** M. Henry Philips, in *Philosophical Transactions*, N<sup>o</sup>. 34. gives the following Proportion for finding the *Tides*.

*First*, Divide a Circle into twelve equal *Parts*, or *Hours*, according to the Moon's Motion, or Distance from the Sun, from the *New Moon* to the *Full*.

*Secondly*, Let the Diameter of the Circle be divided into 90 *Parts* or *Minutes*, that is according to the Time of the Difference of Tides between the *New* or *Full Moon*, and the *Quarters*, which is one Hour and a half.

*Thirdly*, Make *Perpendicular Lines* cross the Diameter of the Circle, from Hour to Hour.

*Fourthly*, Reckon the Time of the *Moon's* coming to the *South* in the Circumference of the Circle, and observe the *Perpendicular Line* that falls from that Point upon the Diameter; and the Proportional *Minutes* cut thereby, will shew how many *Hours* or *Minutes* are to be subtracted from the Time of high Tides at the *New* and *Full Moon*, that so you may have the true Time of the *Tides* that present Day.



Example.

At London, on the Day of the *New* and *Full Moon*, it is *High-tide* at 3 of the Clock; that is, when the *Moon* is 3 Hours past the *Meridian*: And so by the common Rule, the *Moon* being about 4 Days old, it will be *South* about 3 of the Clock, and it will be *High-tide* 3 Hours afterwards; that is, at 6 of the Clock. But now by this Rule, if you count this Time of the *Moon's* coming to the *South*, in the Circumference, the perpendicular Line which comes from 3 to 9, cuts the Diameter in the half at 45 *Minutes*: Which shews, that so much is to be abated from the Time of *High-water*



water in the *New* and *Full Moon*: So that it is *High-tide* 45 Minutes before 6 of the Clock; that is, at 5 Hours 15 Minutes, and not at 6 of the Clock, according to the *common Rules*.

The like you may do for any other Port or Place, knowing the Time of *High-water*, at the *New* and *Full Moon* in that Place: And this may be more readily done, if you set down the Time of *High-water* at the *New* and *Full Moon* under the *Diameter*, as is done for *London* in this Example, where 'tis *High-tide* at 3 of the Clock. So that when the *Moon* is South at 3 of the Clock, the Perpendicular cuts the *Diameter* at 2 Hours, 15 Minutes; which added to the Time of the *Southing*, gives 5 Hours, 15 Minutes; and so when the *Moon* is South at 9 of the Clock, by adding 2 Hours, 15 Minutes, you have the Time of *High-water*, which is 11 Hours, 15 Minutes.

And thus you may easily make a *Table*, which by the *Southing* of the *Moon*, shall readily tell you the Time of *High-tide* at any Time of the *Moon*.

*Note*, If the Difference be not so much between the *Neap-tides* and *Spring-tides*, in other Places as it is in this our Example, the *Diameter* must be divided into fewer Parts.

Our learned Astronomer, Mr. *Flamsteed*, *Philos. Transactions*, N<sup>o</sup>. 143. gives us a new and more correct *Tide-table* (which he also now publishes every Year) improving what Mr. *Philips* had begun, by observing that the Tides did not usually hold out so long as Mr. *Philip's* Calculation made them to do. He found by above 80 Observations of the *High-waters* at *Tower-wharf* and *Greenwich*, That the greatest Differences between the *Moon's true Southing*, and the *High-waters*, were not, as *Philips* said, at *Full*, *New*, and *Quarter Moons*, but the greatest near the *Neaps*, and the less near the highest *Spring-tides*.

There is an Hypothesis to solve the Motion of the Tides, mentioned in *Philos. Transact.* N<sup>o</sup>. 16. from that Learned Mathematician Dr. *Wallis*: In which, he supposes the *Earth* and *Moon* to move round the *Sun*, in a Circle, or Ellipse, described by their common Centre of Gravity. But this Hypothesis places the highest *Annual Tides* not near the Equinoxes, but about *Candlemas* and *All-hollandide*; that is, in the Beginning of *February* and *November*. But I could never find that the Thing was so in Fact; but that, on the contrary, they are always greatest at or near the Equinoxes, as hath been generally observed: I shall therefore refer the Reader to the Ingenious Hypothesis itself, without giving any particular Account of it here.

*The true Theory of the Tides, extracted from that admirable Treatise of Sir Isaac Newton, intitled, Philosophiæ Naturalis Principia Mathematica: By that Excellent Mathematician, Captain Halley.*

The Principle upon which this Author proceeds to explain most of the great and surprising Appearances of Nature, is no other than that of *Gravity*, whereby in the *Earth* all Bodies have a Tendency towards its Centre, as is most evident: And from undoubted Arguments 'tis proved, that there is such a *Gravitation* towards the Centre of the *Sun*, *Moon*, and all the Planets.

V O L. II.

From this Principle, as a necessary Consequence, follows the Spherical Figure of the *Earth* and *Sea*, and of all the other Celestial Bodies; and tho' the Tenacity and Firmness of the solid Parts, support the Inequalities of the Land above the Level; yet the Fluids pressing equally, and easily yielding to each other, do soon restore the *Equilibrium*, if disturbed, and maintain the exact Figure of the Globe.

Now this Force of the Descent of Bodies towards the Centre, is not in all Places alike, but is still less and less, as the Distance from the Centre encreases: And in the said Book it is demonstrated, that this Force decreases as the Square of the Distance encreases; that is, the Weight of Bodies, and the Force of their Fall is less, in Parts more removed from the Centre, in the Proportion of the Squares of the Distance.

As for Example.

A Ton Weight on the Surface of the *Earth*, if it were raised to the Height of 4000 Miles, which let be the Semi-diameter of the *Earth*, would weigh but a Quarter of a Ton, or 500 lb. Weight.

If to 12000 Miles, or 3 Semi-diameters from the Surface; that is, 4 from the Centre, it would weigh but 1 sixteenth Part of the Weight on the Surface, or a Hundred and a Quarter: So that it would be as easy for the Strength of a Man at that Height, to carry a Ton Weight, as here on the Surface to carry a Hundred and a Quarter.

And in the same Proportion does the Velocities of the Fall of Bodies decrease: For whereas on the Surface of the *Earth*, all things fall 16 Foot in a Second, at one Semi-diameter above; this Fall is but 4 Foot; and at 3 Semi-diameters, or 4 from the Centre, it is but  $\frac{1}{16}$  of the Fall at the Surface, or but one Foot in a Second, and at greater Distances both Weight and Fall become very little; but yet at all given Distances, is still something, tho' the Effect become insensible.

At the Distance of the *Moon* (which suppose to be 60 Semi-diameters of the *Earth*) 3600 Pounds Weight but one Pound, and the Fall of Bodies is but  $\frac{1}{3600}$  of a Foot in a Second, or 16 Foot in a Minute; that is, that a Body so far off descends in a Minute no more than the same at the Surface of the *Earth* would do in a Second of Time.

And as was said before, the same Force decreasing after the same manner, is evidently found in the *Sun*, *Moon*, and all the Planets; but more especially in the *Sun*, whose Force is prodigious, becoming sensible even at the immense Distance of *Saturn*. This gives room to suspect that the Force of Gravity is in the Celestial Globes proportional to the Quantity of matter in each of them: And the *Sun* being at least 10000 times (for Instance, tho' he is far bigger) as big as the *Earth*, its Gravitation or attracting Force, is found to be at least 10000 times as much as that of the *Earth*, acting on Bodies at the same Distances.

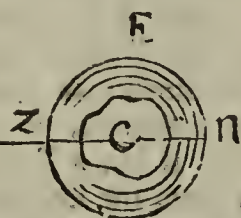
Whence also, all the surprising Phenomena of the Flux and Reflux of the *Sea*, he shews in the like manner to proceed from the same Principle.

If the *Earth* were alone, that is to say, not affected by the Actions of the *Sun* and *Moon*, it is not to be doubted, but the *Ocean* being equally pressed by the Force of Gravity towards the Centre, would continue in a perfect Stagnation, always at the same Height, without ever Ebbing or Flowing;



ing; but it being by him demonstrated, that the *Sun* and *Moon* have a like Principle of Gravitation towards their Centres, and that the Earth is within the Activity of their Attractions, it will plainly follow, that the Equality of the Pressure of Gravity towards the Centre, will thereby be disturbed; and tho' the smallness of these Forces, in respect to the Gravitation towards the Earth's Centre, render them altogether imperceptible by any Experiments we can devise, yet the Ocean being fluid, and yielding to the least Force, by its rising, shews where it is least prest, and where it is more prest by its sinking.

Now if we suppose the Force of the *Moon's* Attraction to decrease as the Square of the Distance from its Centre increases (as in the Earth, and other Celestial Bodies) we shall find, that where the *Moon* is perpendicularly either above or below the *Horizon*, either in *Zenith* or *Nadir*, there the Force of Gravity is most of all diminished, and consequently that there the Ocean must necessarily swell, by the coming in of the Water from those Parts where the Pressure is greatest, viz. in those Places where the *Moon* is near the *Horizon*: But that this may be the better understood, 'twas thought needful to add the following Scheme, where M is the *Moon*, E the Earth, C its Centre, Z the Place where the *Moon* is in the *Zenith*, N where the *Nadir*.



Now by the Hypothesis it is evident, that the Water in Z, being nearer, is more drawn by the *Moon*, than the Centre of the Earth C, and that again more than the Water in N; therefore the Water in Z has a Tendency towards the *Moon*, contrary to that of Gravity, being equal to the Excess of the Gravitation in Z, above that in C. And in the other Case, the Water in N tending less towards the *Moon* than the Centre C, will be less pressed, by as much as is the Difference of the Gravitations towards the *Moon* in C and in N.

This rightly understood, it follows plainly, that the Sea, which otherwise should be Spherical, upon the Pressure of the *Moon*, must form itself into a Spheroidal, or Oval Figure, whose longest Diameter is where the *Moon* is Vertical, and shortest where she is in the *Horizon*; and that the *Moon* shifting her Position, as she turns round the Earth once a Day, this Oval of Water shifts with her, occasioning thereby the two Floods and Ebbs observable in each 25 Hours.

And this may suffice as to the general Cause of the *Tides*: It remains now to shew how naturally this Motion accounts for all the Particulars that have been observed about them; so that there can be no room left to doubt, but that this is the true Cause thereof.

The *Spring-tides*, upon the *New* and *Full Moons*, and the *Neap-tides*, on the *Quarters*, are occasioned by the attractive Force of the *Sun*, in the *New* and *Full*, conspiring with the Attraction of the *Moon*, and producing a *Tide* by their united Forces;

whereas in the *Quarters*, the *Sun* raises the Water where the *Moon* depresses it, and on the contrary; so as the *Tides* are made only by the Difference of their Attraction.

That the Force of the *Sun* is no greater in this Case, proceeds from the very small Proportion the Semi-diameter of the Earth bears to the vast Distance of the *Sun*.

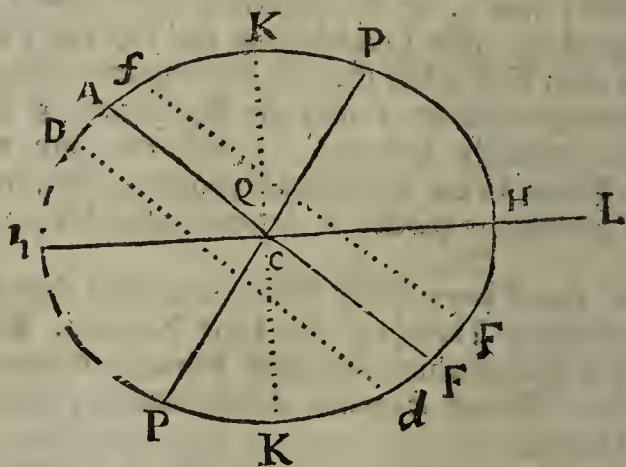
It is also observed, That, *cæteris paribus*, the *Equinoctial Spring-tides* in *March* and *September*, or near them, are the highest, and the *Neap-tides* the lowest; which proceeds from the greater Agitation of the Waters, when the fluid *Spheroid* revolves about a great Circle of the Earth, than when it turns about in a lesser Circle; it being plain, that if the *Moon* were constituted in the Pole, and there stood, that the *Spheroid* would have a fix'd Position, and that it would be always *High-water* under the Poles, and *Low-water* every where under the *Equinoctial*; and therefore the nearer the *Moon* approaches the *Poles*, the less is the Agitation of the Ocean; which is of all the greatest, when the *Moon* is in the *Equinoctial*, or farthest Distant from the Poles.

Whence the *Sun* and *Moon*, being either conjoined or opposite in the *Equinoctial*, produce the greatest *Spring-tides*; and the subsequent *Neap-tides* being produced by the *Tropical Moon* in the *Quarters*, are always the least *Tides*; whereas in *June* and *December* the *Spring-tides* are made by the *Tropical Sun* and *Moon*, and therefore less vigorous; and the *Neap-tides*, by the *Equinoctial Moon*, and therefore are the stronger.

Hence it happens, that the Difference between the *Spring* and *Neap-tides* in these Months, is much less considerable than in *March* and *September*.

And the Reason why the highest *Spring-tides* are found to be rather before the *Vernal*, and after the *Autumnal Equinox*, viz. in *February* and *October*, than precisely upon them, is, because the *Sun* is nearer the Earth in the Winter Months, and so comes to have a greater Effect in producing the *Tides*.

Hitherto we have considered such Affections of the *Tides* as are universal, without Relation to particular Cases; what follows from the differing Latitudes of Places, will be easily understood by the following Figures.



Let APPEP be the Earth covered over with very deep Waters, C its Centre, PP its Poles, AE the *Equinoctial*, Ff the Parallel of Latitude of a Place, Dd another Parallel at equal Distance on the other side of the *Equinoctial*, Hh the two Points where the *Moon* is Vertical, and let K.K be the great Circle wherein the *Moon* appears Horizontal.



It is evident, that a *Spheroid* described upon H b and K K, shall nearly represent the Figure of the Sea; and C f, C D, C F, C d, shall be the Heights of the Sea in the Places f, D, F, d, in all which it is *High-water*: And seeing that in 12 Hours time, by the diurnal Rotation of the Earth, the Point F is transferred to f and d to D, the Height of the Sea C F, will be that of the *High-water*, when the *Moon* is present, and C f that of the other *High-water*, when the *Moon* is under the Earth; which in the Case of this Figure is less than the former C F.

And in the opposite Parallel D d, the contrary happens: The rising of the Water being always alternately greater and less in each place, when it is produced by the *Moon* declining sensibly from the Equinoctial, that being the greatest of the two *High-waters* in each diurnal Revolution of the *Moon*, wherein she approaches nearest either to the *Zenith* or *Nadir* of the Place. Whence it is, that the *Moon* in the Northern Signs in this part of the World, makes the greatest *Tides* when above the Earth, and in the Southern Signs, when under the Earth; the Effect being always the greatest where the *Moon* is farthest from the Horizon, either above or below it.

And this alternate Increase and Decrease of the *Tides*, has been observed to hold true on the Coast of *England*, at *Bristol* by Captain *Sturmy*, and at *Plymouth*, by Mr. *Colepreffe*.

But the Motions hitherto mentioned, are somewhat altered by the Libration of the Water, whereby, tho' the *Action* of the *Luminaries* should cease, the Flux and Reflux of the Sea would for some time continue: This Conservation of the impressed Motion diminishes the Difference that otherwise would be between two consequent *Tides*, and is the Reason why the highest *Spring-tides* are not precisely on the *New* and *Full Moons*, nor the *Neaps* on the *Quarters*; but generally they are the Third *Tides* after them, and sometimes later.

All these things would regularly come to pass, if the whole Earth were covered with Sea very deep; but by Reason of the shoalness of some Places, and the narrowness of the Streights, by which the *Tides* are in many Places propagated, there arises a great Diversity in the Effect, and not to be accounted for, without an exact Knowledge of all the Circumstances of the Places; as of the Position of the Land, and the Breadth and Depth of the Channels by which the *Tide* flows; for a very flow and imperceptible Motion of the whole Body of the Water, where it is (for Example) two Miles deep, will suffice to raise its Surface 10 or 12 Feet in a *Tide's* Time; whereas, if the same Quantity of Water were to be conveyed upon a Channel of 40 Fathom deep, it would require a very great Stream to effect it, in so large Inlets as are the Channel of *England*, and the *German Ocean*; whence the *Tide* is found to set strongest in those Places where the Sea grows narrowest, the same Quantity of Water being to pass through a smaller Passage: This is most evident in the *Streights* between *Portland* and *C. de Hogue* in *Normandy*, where the *Tide* runs like a Sluice, and would be yet more between *Dover* and *Galais*, if the *Tide* coming about the Island from the North did not check it. And this Force being once impressed upon the Water, continues to carry it about the Level of the ordinary Height in the Ocean, particularly where the Water meets a direct Obstacle, as it is in *St. Malo's*;

and where it enters into a long Channel, which running far into the Land, grows very freight at its Extremity; as it is in the *Severn-Sea*, at *Chepstow* and *Bristol*.

This Shoalness of the Sea, and the Intercurrent Continents, are the Reason that in the open Ocean the Time of *High-water* is not at the *Moon's* Appulse to the Meridian, but always some Hours after it; as it is observed upon all the West Coast of *Europe* and *Africa*, from *Ireland* to the *Cape of Good Hope*: In all which, a *South-West Moon* makes *High-water*; and the same is reported to be on the *West* of *America*.

But it would be endless to account all the particular Solutions, which are easy *Corollaries* from this *Hypothesis*; as, why the Lakes, such as the *Caspian-Sea*, and *Mediterranean-Sea*; such as the *Black-Sea*, the *Streights*, and *Baltick*, have no sensible *Tides*: For *Lakes*, having no Communication with the Ocean, can neither increase or diminish their Water, whereby to rise, and fall; and Seas that communicate by such narrow Inlets, and are of so immense an Extent, cannot in a few Hours time receive, or empty Water enough to raise or sink their Surface in any thing sensibly.

Lastly, to demonstrate the Excellency of this Doctrine, the Example of the *Tides* in the Port of *Tunking* in *China*, which are so extraordinary, and differing from all others we have yet heard of, may suffice. In this Port there is but one Flood and Ebb in 24 Hours; and twice in each Month, viz. when the *Moon* is near the Equinoctial, there is no *Tide* at all, but the Water is Stagnant; but with the *Moon's* Declination there begins a *Tide*, which is greatest when she is in the Tropical Signs; only with this Difference, that when the *Moon* is to the North-ward of the Equinoctial, it Flows when she is above the Earth, and Ebbs when she is under, so as to make *High-water* at *Moon's* Setting, and *Low-water* at *Moon's* Rising: But on the contrary, the *Moon* being to the Southward, makes *High-water* at Rising, and *Low-water* at Setting, it Ebbing all the Time she is above the Horizon. As may be seen more at large, in the *Philosoph. Transact.* N. 162.

The Cause of this odd Appearance, is proposed by Sir *Isaac Newton*, to be from the Concurrence of two *Tides*, the one propagated in 6 Hours, out of the great *South-Sea*, along the Coast of *China*; the other out of the *Indian-Sea*, from between the Islands, in 12 Hours, along the Coast of *Malacca*, and *Cambodia*.

The one of these *Tides*, being produced in North-Latitude, is, as has been said, greater when the *Moon* being to the North of the Equator, is above the Earth, and less when she is under the Earth.

The other of them, which is propagated from the *Indian-Sea*, being raised in South Latitude, is greater when the *Moon* declining to the South is above the Earth, unless when she is under the Earth; so that of these *Tides*, alternately greater and lesser, there comes always successively two of the greater, and two of the lesser together every Day; and the *High-water* falls always between the Times of the Arrival of the two greater Floods, and the *Low-water* between the Arrival of the two lesser Floods. And the *Moon* coming to the Equinoctial, and the alternate Floods becoming equal, the *Tide* ceases, and the Water stagnates; but when she has passed to the other side of the

the



the Equator, those Floods which in the former Order were the least, now becoming the greatest, that which before was the Time of the *High-water*, now becomes the *Low-water*, and the Converse; so that the whole Appearance of these strange *Tides*, is, without any forcing, naturally deduced from these Principles, and is a great Argument of the Certainty of the whole *Theory*.

The *Theory of Des Cartes*, whereby he endeavours to explain the Phænomena of *Tides*, supposes the *Moon* to move round the Earth in an Ellipsis, in whose Centre the Earth is placed, so that by this means the *Moon* will have two *Apogæums*, and two *Perigæums*; and according to him she must always be in one of her *Perigæums*, at the Time of her Opposition, or Conjunction; so that then he supposes her to press more strongly upon the Sea, than she doth at her Quadratures, when he saith she is in her *Apogæum*, and consequently hath a weaker Pressure: But now besides that, if this were so, it would not solve the Thing, the Fact itself is notoriously False; for the *Moon* is as often in her *Apogæum* at New, and Full, as she is in her *Perigæum* at those Times; tho' it seldom happens, that she is exactly in either, at her Lunations. *Vid. Mr. Keil's Examination of Burnet's Theory, Introduct. p. 17.*

Dr. Gregory, in his *Astronomy, Book iv. Prop. 65. pag. 384.* demonstrates also; that if the Globe of the Earth, were every where covered over with a deep Sea (not now considering the Figure, which would arise from its Revolution round its Axis) it would put on the Figure of an oblong Spheroid, whose Axis produced, would pass thro' the *Moon*; and this, by Reason of the Gravitation of the Parts, the Water towards the *Moon*: And for the same Reason, the Earth would put on an oblong Spheroidical Figure, whose produced Axis, would also pass thro' the *Sun*.

And then in the next Proposition he proves, that the *Flux, and Reflux of the Sea, is occasioned by the Water covering our Globe, its putting on two oblong Spheroidical Figures, whose Axis produced, would pass through the Moon and Sun.*

And this true Cause of the *Tides*, he saith, was first discovered by the great *Kepler*, and afterwards improved very much by our Incomparable Sir *Isaac Newton*; which shewed that the Sea must needs rise both under the *Moon*, and in the Part diametrically opposite to that.

And this Spheroidical Figure of the Water of the Sea, which like two Mountains is stretcht out, one towards the *Moon*, and the other to the Part opposite to her, is continually moving, or shifting according to the daily Motion of the *Moon*, which it follows (or rather indeed, the Earth moving towards the East in its daily Motion, shifts itself away from these Mountains of Water, which keep as it were immoveable under and opposite to the *Moon*, as she more slowly moves towards the East) hence I say it must needs be, that the Water must twice rise and fall in 25 Hours; in which Time the *Moon* moves from the Meridian of any Place, to the same again.

And because the Water of the Earth will swell, or be raised in those Places to whom the *Sun* is in the *Zenith*, or *Nadir* (as he proves, *Prop. 64.*) altho' much less than when the *Moon* is so posited: Therefore in the Conjunction, and Opposition of these Luminaries, the aforesaid Protuberance of the Water will be conjoined; and consequently then the highest *Spring-tides*, and the lowest Ebbs

will be when both those Luminaries are in the Horizon of any Place; because the Water is then elevated, and now depressed by the conjoint Force of both.

But in the Quadratures of the Luminaries, the *Sun* elevates the Water where the *Moon* makes it fall, and makes it fall where the *Moon* elevates it; so that the *Elevation* of the Water depending only on the Difference of these Forces, will be the least of all, and so for the *Depression*. Between the Syzygies, and the Quadratures, the Effects of the Luminaries on the Water, will be at a Mean between the two former.

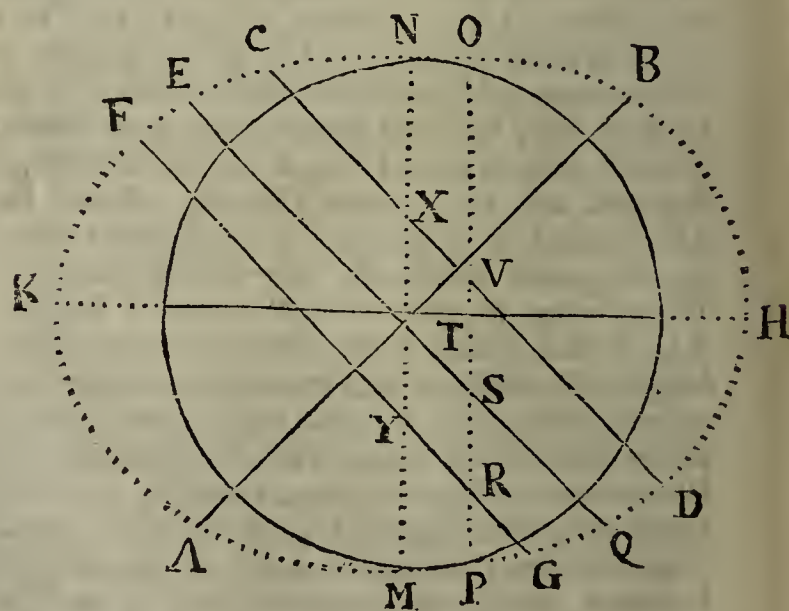
When the *Moon* is in the Equinoctial, the two opposite Protuberances, or Eminences of the Water, will be also in the Earth's Equator, and each of them describing that greatest Circle of the Earth, by its diurnal Revolution, it will move swifter; and when it is thrown towards the Shoars, will rise higher there; besides that, something must also be allowed for the Equatorial Diameter of the Earth, being its longest, and consequently the Water there being something nearer to the Luminary, will be raised higher, by their Influences, than in other Parts.

And therefore whenever the Luminaries are either in Conjunction, or Opposition, in the Equator, their Forces will be conjoined to raise or elevate the Sea at the Equator; as happens at the Syzygies next the Equinoxes, or in or near *March* and *September*, when we have always the greatest *Annual-tides*; as the Tides at the Quadratures of those *Moons* are always the least, or most *Neap*.

Again, the Tides (other things considered) are always greatest when the Luminaries are in *Perigæo*, and least when they are in *Apogæo*; and since this is the Case of the *Moon* in every Lunation, but of the *Sun* only in the Winter, this joined to the former, occasions that the greatest Tides in the Syzygies, and the least in the next Quadratures, do precede the Vernal Equinox, and follow the Autumnal one.

Hitherto the Properties of the *Tides* have been considered only universally, as they affect the whole Globe of the Earth; it remains, that those should be next spoken of, which arise from the different Latitudes of different Places.

To which purpose, let BEKAQH represent the Earth, whose Centre is at T, its North Pole A, the other B: EQ the Equator, and CD, FG, two Parallels to it, one toward the North, the other toward the South.



Let



Let the Water round the Earth conform itself into an oblong Spheroid (because of the *Moon's* being near it) whose Axis *K H*, produced towards *H*, shall pass through the *Moon*: Then shall *T H*, or *T K*, be the greatest Height of the Water (reckoning from the Centre *T*) and *T M*, or *T N*, the least; which latter is equal to the Height of the Water in any Point of the Circle *N M*: *v. gr.* where ever it meets with the Parallels, *C D*, *F G*, as suppose in *X* or *Y*.

Also the Right-Lines *T C*, *T F*, *T D*, and *T G* (being supposed to be drawn) will denote the Height of the Water in the several Points *C*, *F*, *D*, and *G*: Then drawing the Circle *P O*, parallel to *N M*, the supposed Right-Lines, *T O*, *T V*, *T S*, *T R*, and *T P*, will be the Heights of the Water in the Points *O*, *V*, *S*, *R* and *P*, where the said Circle meets with the Equator and its Parallels.

This being supposed; let us consider any Place on the Earth, by its diurnal Rotation, to describe the Parallel *C D*: It is then plain, that when the Place is at *D*, *T D* will then be the greatest Height of that Water, when the *Moon* is in the *Meridian* of the Place; but the Water will be at lowest, when that Place hath moved to *X*; and then highest again when it is come to *C*, as hath been before shewn.

But now because *T D* is longer than *T C* (as being nearer to the longest of all *T H*) in the present Case, when the *Moon* declines towards the elevated Pole, the Height of the Water will be greater when the *Moon* is in the *Meridian*, above the *Horizon*, than when in the same Circle below it.

In like manner *T G*, will be less than *T F* (as being nearer the shortest of all *T M*) that is in the Place, describing the Path, or Circle *F G*, by the Earth's diurnal Motion. *T G*, will be the greatest Height of the Water, happening while the *Moon* declines towards the depressed Pole *A*, and is on the *Meridian* above the *Horizon*; but this is less than its greatest Altitude, which happens when the *Moon* comes to the other half of the *Meridian*.

Moreover, the Difference of this Tide, now greater, now lesser (in Places situate without the Equator, according as the *Moon* moves towards the visible, or latent part of the *Meridian*) will be greater, if it be conjoined with the Causes above-mentioned, and which will produce a like Effect, *v. gr.* at the *Solstices*; for then in the *Syzygies*, both the Luminaries do most of all decline from the Equinoctial; and such a *Declination* (it hath been shewed) occasions the *Alternation of the Tides*.

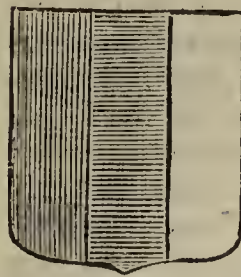
And this Effect will yet be encreased when the ascending Node of the *Moon's* Orbit passes the Vernal Equinox; for then the *Moon* conjoined to the *Sun*, declines towards the North, or South, by the Quantity of her greatest Latitude, above the Declination, which is equal to the *Sun's* greatest Declination.

All which things are in this State if the Earth be supposed to be quite covered over with Water, to a great Depth; but because of the Land, Islands, Straights, &c. there will be an infinite Variety in the Phenomena of the *Tides*; yet there is no doubt, but that if the Situation of Places, &c. be well considered, and Observations of the *Tides* there exactly made, all things will be found to agree very well with this Theory, and to be easily accountable from it.

**TIDES**: The Tides of the great Ocean being caused by the Action or Attraction of the Moon

upon it (chiefly) and because that part of the Ocean, which is directly under the Moon, will be more attracted by it than the rest; there the Ocean must swell or rise, and the Water will run from other Parts thither.

But from hence only it will not follow, that there should be Tides produced in Rivers and in Land, Seas, Lakes, &c. of little or no breadth; because they are so narrow, that the Moon cannot act stronger on one Part than on another; and so there being no difference of Attraction, there is no Reason why one part should swell or rise more than another; for, the Attraction being equal, the Water cannot shift or move from one Place to another.



**TIERCE**, in Heraldry, signifies, that the Shield divided into three equal Parts are of many different Colours or Metals; or if the *Chief* and *Base* are both of the same Colour, when they are divided by a *Fesse*, then the Colour of the Field is only to be expressed, and the *Fesse* mentioned. But if otherwise, it is proper to say *Tierce en Fesse*, and to mention the first, second, or third Colours, or Metals; and if it be divided in *Pale*, to say *Tierce en Pal*, *F.*

**TIGE**, in Architecture, is the Shaft of a Column from the Astragal to the Capital.

**TIERCE**, or a *Third*, is a Term in Musick, signifying a certain Division of the *Monochord*, in which if the Terms be as 5 to 4, 'tis called a *Tierce Major*, or a *Diton*; but if the Terms are as 6 to 5, then 'tis called a *Tierce Minor*, or *Demi-Diton*.

**TIES** aboard a Ship, are those Ropes by which the Yards do hang: And when the Halliards are strained to hoise the Yards, these *Ties* carry them up.

**TILLER**, the very same with the Helm of a Ship: It is most properly used in a Boat where that which would be the Helm in a Ship, is called the *Tiller*.

**TIMBER** (or rather *Timmer*, saith *Guylim*) is the Herald's term for the Crest, which in any Achievement stands a top of the Helmet.

**TIME**, in Musick, is that Quantity, or Length, whereby is assigned to every particular Note, its due Measure, without making it either longer or shorter than it ought to be; and it is two-fold, *viz.* *Duple* or *Common*, and *Triple*.

*Duple*, or *Semi-breve Time*, generally called *Common*, because most used, is when all the Notes are encreased by two: As 2 *Longs* make a *Large*, 2 *Breves* a *Long*, 2 *Semi-breves* a *Breve*, 2 *Minims* a *Semi-breve*, 2 *Crotchets* a *Minim*, 2 *Quavers* a *Crotchet*, 2 *Semi-quavers* a *Quaver*, and 2 *Demi-Semi-quavers* a *Semi-quaver*.

This sort of Time is usual in *Anthems*, *Almains*, *Pavans*, *Fantasies*, &c.

*Triple Time*, is that wherein the Measure is counted by *Threes*: As one *Semi-breve* is equivalent to 3 *Minims*, one *Minim* to 3 *Crotchets*, &c. So that this swifter Time or Measure is proper for Airy Songs, and Light Lessons: As *Courants*, *Sarabands*, *Jiggs*, &c.

To these sorts of Time may be added *Sesquialteran Proportion*, which signifies a *Triple* Measure of three Notes, to two such like Notes of the *Common Time*.



**TIME**, is a certain Measure depending on the Motion of the Luminaries, by which the Distance and Duration of things is measured; and is either *Astronomical*, which is simply taken from the Motion of the Stars; or *Civil*, which is Astronomical Time accommodated to vulgar Uses.

*Astronomical*, *Mathematical*, or *Absolute Time*, flows equably in its self without Relation, to any thing external; and by another Word is called *Duration*.

But *Relative*, *Apparent*, or *Vulgar Time*, is the sensible, and external Measure of any Duration estimated by Motion, and this the Vulgar uses instead of true *Time*.

**TIN-GLASS.** See *Bismuth*.

**TINCTURE**, the Heralds call the Colours in an Escutcheon, or Coat of Arms, *Tinctures*.

**TINEA**, when a sort of running Sores in the Head, full of little Holes (called *Achores*) continue long, or be too slowly or ill cured, they grow into *Tinea's*, i. e. crusty stinking Ulcers of the Head, which gnaw, and consume its Skin; therefore 'tis deservedly reckoned amongst the Diseases of Children, but when they are a little grown; for tho' adult Persons are sometimes troubled with this Disease, yet they contracted the Rudiments, and Seeds of it in their Infancy. It is called *Tinea*, which signifies a Moth, from those little Worms which eat, and consume Clothes; because those Ulcers prey upon the Skin of the Head, as those Animals upon Clothes. What the *Greeks* called this Distemper, is not so obvious. *Blanchard*.

**TIN-KILN**, is used for the burning of the *Mundick* from the Tin-Ore. See its Description under Tin.

**TIN**: In *Philosophical Transactions*, N<sup>o</sup>. 69. and N<sup>o</sup>. 138. you have the following Account of the Manner of *Finding*, *Digging for*, *Pressing* and *Blowing* of Tin.

The Miners imagine, that, before the Deluge, the uppermost Surface of the *Mineral Veins*, or *Loads*, lay parallel to the upper Surface of the Earth; but that, in the Flood, they were moved, loosened, and torn off; and that by the descending of the Waters into the Valleys, both the Earth or *Grewt*, and those Mineral Stones or Fragments so torn off from the *Loads*, (and which they call *Shoad*) were, together with, and by the Force of the Waters, carried beneath their proper Place, and from some Hills, even to the Bottoms of the neighbouring Valleys, and from thence by Land-Floods down into the Rivers.

On these Suppositions, they proceed thus in *Training* or pursuing of a *Load*: Where they suspect any Mine to be, they diligently search that Hill and *Country* (as they call the Place where the *Mine* lies) that they may the better know the *Grewt* and the Stones, when they meet them at a Distance in the Bottom of a neighbouring Valley. They take notice also of the *Frets* or Openings which are made in the Banks of Rivers, newly made by great Land-Floods, which are usually then very clean, to see whether there be any Metal-line Stones in the Sides, or Bottoms; together with the *Cast* of the *Country*, as they call it, i. e. any Earth of a different Colour from the rest of the Bank: And this is a great help to them, to discover which Hill, or which side of it to search. The Mineral Stones are discovered, either by their Weight, or their Porosity; for most Tin-Stones are porous, not unlike great Bones, almost thoroughly calcined. Yet Tin sometime lies in very firm Stones; and Dr. *Chr. Merret* saith, that they are usually found betwixt two Walls of Rocks, which

are commonly of an Iron Colour, of little or no Affinity with the Tin. *Vid. Philosophical Transact.* N<sup>o</sup>. 138.

Another Way they have to discover whether the Stones contain any Ore, is, what they call *Vauning*, which is, to powder the Stone, Clay, &c. or whatever is suspected to contain any Metal; and then placing it on a *Vauning Shovel*, then will the Gravel remain in the hinder Part, and the Metal at the Point of the Shovel; whereby the Nature, Kind, and Quantity of the Ore is very nearly guessed at.

If there be no *Shoad* found in these *Frets*, they trust not to any found in the River, it being uncertain from whence the Water may have brought them. But then they go to the sides of the Hills most suspected, where there is a Convenience of bringing a little Stream of Water (the bigger the better) and then they cut a *Leat* or *Gurt*, as they call it, that is, a Trench about two Foot over, and as deep as the *Shelf*; and by this means turn the Water, running two or three Days, that by washing away the Earth from the Stones, it may discover the *Shoad*. If they find any, they conclude there is *Load* in the upper Part of the Hill, or at least a *Squat*. Then at the foot, or bottom of the Hill, they sink what they call an *Essay-hatch*, i. e. a Hole about six Foot long, and four broad, and always as deep as the *Shelf*; and if they find no *Shoad* there, when they come to the *Shelf*, there is none to be expected: Tho' sometimes the *Shoad* is washed clean away, when you come within two or three Foot of the *Load*, which then lies so much further up in the Hill. But if they find *Shoad*, they are almost at a Certainty; and this is held as an infallible Rule, that the nigher the *Shoad* lies to the *Shelf*, the nigher the *Load* is at hand, and *vice versa*.

If they find no *Shoad* in the first *Hatch*, they ascend usually about twelve Fathom, and then sink another, as before; and if no *Shoad* appear here, then they go as far on each hand side-ways, and sink there, as before. And so they ascend proportionably with three or more *Hatches* (if the Space of Ground require it) as it were in Breast, 'till they come to the top of the Hill. And if they find no *Shoad* in any of these *Hatches*, farwel to that Hill.

But if they find any *Shoad* in any *Hatch*, then they keep their ascending *Hatches* from thence in a Right-Line; and as they draw nearer the *Load*, they lessen the first Proportion of twelve Fathom to six, or yet less, as Conjecture directs them. If they find *Shoad* lying near the *Shelf* in one *Hatch*, and none in the next ascending, they conclude they have over-shot the *Load*, and then they sink nigher that *Hatch*, in which they last found the *Shoad*. Sometimes they find two different *Shoads* in the same *Hatch*, at different Depths, and then they have a Certainty of another *Load* above the former; and it may be in *Training* up to the second, they meet with the *Shoad* of a third. Some Tinnors affirm, that the seven *Loads* may lie parallel one to another in the same Hill, but yet only one *Master-Load*; the other six, three on each side, being the lesser Concomitants; and so may five lie, three are common.

Every *Load* hath a peculiar coloured Earth or *Grewt* about it, which is found also with the *Shoad* in a greater Quantity, the nearer the *Shoad* lies to the *Load*; and so lessens by Degrees to near a quarter of a Mile's distance; but further than that, the peculiar *Grewt* is never found with the *Shoad*.

A Valley



A Valley may lie so, at the Feet of three several Hills, that they may find three several *Deads*, i. e. common loose Earth, in which the *Shoad* lay, and which is not only contiguous to the *Load*: This they call the *Run* or *Cast* of the *Country*, or of each Hill; and the Knowledge of this is very necessary, in order to surer *Training* of them one after another, as they lie in order, according to the foregoing Rules of *Essay-Hatches*; for the uppermost will direct you which Hill to begin first.

It may be, after they have *trained* up the Hill, they find nothing but a *Bonny* or *Squat*, which likewise have their *Shoad*. Their Form is about two or three Fathom long, and half as broad, few larger and most less: These communicate with no other *Load* or *Vein*, neither doth it send forth any of its own, but is entire of itself, and perhaps will go down into the *Shelf*, five or six Fathom deep, and there terminate.

The Manner of their Digging the Ore, is thus:

When they have found the *Load*, and last *Essay-Hatch*, 'tis then called a *Tin-shaft*, or *Tin-hatch*, which is sunk down about a Fathom, and then is left a little long square Place, called a *Shamble*; and so they continue sinking from *Cast* to *Cast* (that is, as high as a Man can conveniently throw, or *cast* up the Ore with a Shovel) 'till they either find the *Load* to grow small, or degenerate into some sort of *Weed*, which are divers; as *Mundick*, or *Maxy*, corrupted from *Marchasite*; and this is white, yellow, and green. *Daze*, which is a kind of glittering Stone, enduring the Fire, of different Colours; as white, black, and yellow: *Iremould*, black and rusty; *Caul*, which is red, differing both from *Mundick* and *Daze*, or *Spar* (enduring the Fire) which *Marchasite* will not; *Glisten*, which is Blood-red and Black.

Then they begin to make a Drift three Foot wide, and seven Foot high; and if the *Load* be not broad enough of itself, as some are scarce half a Foot, then they usually break down the *Deads*, or that part of the *Shelf* which contains no Metal, but encloseth the *Load*, as a Wall between two Rocks, and then they begin to rip the *Load* itself.

The Instruments they use, are, 1. A *Beele*, or *Cornish Tubber*, i. e. double Points of eight or ten Pounds, sharpened at both Ends, steeled and holed in the Middle: This, in a hard Country, will last about half a Year, but must be new pointed every fourteen Days.

2. A *Sledge*, flat-headed, from ten to twenty Pound; will last about seven Years, new ordered once a Quarter. 3. Gads, or Wedges, of two Pounds, well steeled at the Points, and Four-square; these will last three or four Days, or a Week; and then must be new sharpened. 4. Ladders. 5. Wheelbarrows to carry the *Deads* and Ore out of the *Drifts* or *Adits*, to the *Shambles*. There are two Shovel-men, and three Beele-men, which are as many as one *Drift* can contain, without hindering one another. The *Beele-men* rip the *Deads* and Ore; the *Shovel-men* carry it off, and land it, by casting it up with Shovels from one *Shamble* to another; unless where there is a *Winder* with two *Keebles* or Buckets, one of which comes up as the other goes down.

It is usually observed, that the *Tin Loads* run East and West, and then they constantly dip towards the North, and sometimes as much as three

Foot in eight perpendicular. But in the higher Mountains of *Dartmoor*, there are some considerable *Loads* that run North and South, and these dip to the East.

Four or five *Loads* may a while run parallel to one another in the same Hill, as hath been known in *Kingsdon* in *Cornwall*, and then turn in and meet altogether in one *Hatch*, and after separate again, and run parallel, as before.

The Breadth of *Master-Loads* is generally from three to seven Feet, seldom larger, unless where several *Loads* unite, and make a Knot, or send forth Springs and Veins: But they do not retain the same Breadth in all Places.

The *Load* is usually in a hard rocky Country, made up of *Metal*, *Spars*, and other *Weeds*, as it were all along in a continued Rock; but it hath many Veins and Joints.

In most Places they meet with Water at some Feet deep from the *Load*, at others not at many Fathoms; it runs continually through the Heart of the *Load*.

When it begins to trouble us, we begin at the Foot of the Hill, a *Drift* scarce half so big as that of the *Load*, and work it on a Level, 'till we come up to the *Load*. But where they have not this Convenience, or if they pass that Level, then they are forced to draw it up with Winders and Keebles, or force it up with Pumps. Some, but very few Pumps may be dry. They observe, that when they have Water, they never want Air sufficient for Respiration, and for their Candles to burn in; yet sometimes in a soft clayey Country, the Air is so condensed, as to become in a manner a *Damp*, and to require an *Air-Shaft* for a *Vent*: which *Damps* are sometimes enlarged by working of the *Mundick* with the Ore.

If the Country be not strong enough, they underprop their *Drifts* with *Stemples* and *Wall-plates*, placed much like a Carpenter's Square on the one side, and over-head.

To know which way the *Load* inclines, to bring an *Adit*, or to sink an *Air-shaft* in the desired Place, the Use of the *Dial* is needful; which they call *Plumming* and *Dialling*, and is thus performed. A skilful Person first fastens the end of a long Line at a known Place, and then exactly observes the Point at which the Needle of his *Dial* or *Compass* rests; and at the next Flexure, or Winding, he makes a Mark on the Line, and again notes the Point at which the Needle stands at this second Station; and so he proceeds from turning to turning, still marking the Points and his Line, 'till he comes to the intended Place. Then he repeats above ground what he had done below, and his *Dial* and Line leads him, 'till he come exactly over the Place where he ended the *Mine*.

The Manner of *Dressing the Tin*, is thus:

When the Ore is landed, and the greater Stone broken at the top of the *Mine* by the *Shovel-men*, 'tis brought on Horses to the *Stamping-Mill*, whence the Ore is landed at the Head of the *Pass*, (i. e. two or three Bottom-boards, with two Side-ones, set slope-wise) in which the Ore slides down into the *Coffer*; but that it may not tumble down all at once, there is placed a *Hatch* nigh the lower End of the *Pass*, (that it is a Thwart-board to keep up the Ore.) Beneath that, comes in the *Cock-water* in a Trough, cut in a long Pole, which, with the Ore falls down into the *Coffer*, (i. e. a long Square of the firmest



firmest Timber, three Foot long, and one Foot and half over) wherein are the three usual *Lifters*, placed between two strong broad *Lones*, having two *Braces*, or Thwart-pieces, on each Side, to keep them steady as a Frame, with *Stamper-Heads*, weighing about thirty or forty Pound each of Iron, which serve to break the Ore in the said *Coffer*. These *Lifters*, being about eight Foot long, and half a Foot square, of Heart of Oak, and having as many *Timbers* or *Guiders* between them, are lifted up, in order, by double the Number of *Tap-pels* (fastened to as many *Arms*, passing diametrically to a great Beam, turned by an *Over-shot Water-wheel* on two *Boulters*) which exactly, but easily meet with the *Tongues* so placed in the *Lifters*, as that they quickly slide from each other, suffering the *Lifters* to fall with great Force on the *Ore*, thereby breaking it into small Sand, which is washed out by the Cock-water, thro' a Brass Grate, holed very thick, and placed within two Bars of Iron at one End of the *Coffer*, into the *Launder*, i. e. a Trench cut out in the Floor, eight Foot long, and ten over, and stopped at the other End with a Turf; so that the Water runs away, and the Ore sinks to the Bottom; which, when full, is taken up and emptied with a Shovel.

The *Stamping-Mill* is thus contrived to go two Hours, or more, after they give over attending it. There is a *Tiller*, or long Pole, fastened without at one End to the *Slew* or *Ponder*, i. e. that loose and last Part of the Trough, that conveys the Stream to the *Over-shot-Wheel*. Then, at the other End, there is tied a short Rope, with a transverse Stick at the End of it, curiously, but Trap-ways, hitched at both Ends, under two little Pins, fastened in the *Lones* for that Purpose: There is another Pin set in one of the *Lifters*, at such an exact Height, as that if there be no *Ore* in the *Coffer*, to keep that *Lifter* high enough, the purposed Pin, in descending, knocks out the Water, carrying it quite over the *Mill-wheel*; so that when the *Coffer* is emptied, the *Mill* rests of course. The *Launder* is divided into three Parts, the *Fore-head*, the *Middle*, and the *Tail*. That *Ore* which lies in the *Fore-head*, or within one Foot and a half of the Grate, is the best Tin, and is taken up in a Heap apart; the *Middle* and *Tail* is another Heap, which is accounted the worst. This latter Heap is thrown up by the *Trambling Buddle*, that is, a long square *Tye* of Boards, or *Slate*, about four Foot deep, six long, and three over; wherein stands a Man with a *Trambling-shovel* in his Hand, to cast up the *Ore*, about an Inch thick, on a long square Board, just before him, and as high as his Middle, which is called the *Buddle-head*; and with the Edge of his Shovel, he dexterously cuts and divides it long-ways, in respect of himself, about half an Inch asunder; in which little Cuts, the Water coming gently from the Edge of an upper plain Board, carries away the Filth, and lighter Part of the prepared Ore first, and then the Tin immediately after, all falling down into the *Buddle*; where, with his bare Foot, he smooths it transversely, to make the Surface the plainer, that the Water, and other Heterogeneous Matter, may, without Lett, pass away the quicker.

When this *Buddle* grows full, they take it up; here distinguishing again the *Fore-head* from the *Middle* and *Tails*, which are *trambled* over again: But the *Fore-head* of *this*, with the *Fore-head* of the *Launder*, are *trambled* in a second *Buddle*, but

not different from the first. In like manner, the *Fore-head* of this being likewise separated from the two other Parts, is carried to a *third*, or the *drawing Buddle*; whose Difference from the rest is only this, that it hath no *Tye*, but only a plain sloping Board, whereon 'tis once washed with the *Trambling-shovel*, and so it new names the Ore *Black Tin*, i. e. such as is compleatly ready for the *Blowing-House*.

There is also another more curious Way, called *Sizing*; that is, instead of a *Drawing Buddle*, they use a Hair-sieve, through which they sift the Ore, casting back the Remainder into the *Tails*, and new *trambling* it.

After the second *trambling* it, they take that *Fore-head* in the second *Buddle*, and *dilve* it (i. e. putting it into a Canvas-sieve, in a large Tub of Water, and shaking it lustily) so that the Filth gets over the Rim of the Sieve, leaving the *Black Tin* behind, which is put into *Hogsheds*, covered and locked, 'till the next *Blowing*.

The *Tails* of both *Buddles*, after two or three *Tramblings*, are cast out into the first *Strake* or *Tie* (which is a Pit made purposely to receive them) and what over-small Tin else may wash away in *Trambling*.

There are commonly three or four of them successively, which contain two sorts of Tin, the one which is too small, the other too great. The latter is new ground in a *Craze-mill* (which is just like a Grist-mill, with two Stones, an upper and an under) and after that, *trambled* in order. The former, by reason of its exceeding Smallness, is dressed on a *Reck*, or Frame of Boards, about three Foot and a half broad, and six long, and which turns upon two Iron Pins, fastened in both ends, and the whole placed between two Posts; so that it hangs in an *Æquilibrium*, and may, like a Cradle, be moved easily either way with the Shovel and Water.

#### Blowing of Tin.

When they perceive much *Mundick* in their Tin, which makes it brittle and hard, they are necessitated to burn away the *Weed* in a *Tin Kiln*. This Kiln is four-square, and at the top hath a large Moor-stone about six Foot long, and four broad; in the middle of which is a square Hole of about half a Foot in Diameter: About a Foot beneath this Stone, is placed another, which is not so long by half a Foot; because it must not reach the innermost, or back part of the Wall, which is the open Place, through which the Flame ascends from a lesser Place below that, where a very strong Fire of Furze is constantly made. The *Fore-part* is like a common Oven; but near the back, on one side, there is another little square Hole. When the Kiln is thoroughly heated, the *black Tin* that is to be burnt, is laid on the Top-stone, and as much of it is cast down by the square Hole, on the second, or Bottom-stone, as will cover it all over, about three or four Inches thick. Then the Hole at the top is immediately covered with green Turfs, that the Flame may reverberate the stronger; and a Rake-man, with an Iron Cole-rake, constantly spreads and moves the Tin, that all parts of the *Mundick* may get uppermost of the Tin, and so be *burned* away; which we certainly know by this, that then the Flame will become *yellow* (as usual) and the *Stench* lessened: for whilst the *Mundick* behind burns, the Flame is exceeding blue. Then with the



the Rake he thrusts it down at the open Place into the open Fire, and receives a new Supply of Tin from above. Now when the Place beneath, where the Fire is made, grows full of Tin, Coals, and Ashes, with the Rake he draws it forth with the Coals at the little square Hole, on the one Side, near the Back; where the Ore, fiery hot and red, lies in the open Air to cool; which it will scarce be in three Days, because of the Coals that lie hid in it; but when they cannot stay so long, they quench it with Water, and it is like Mortar. And whether it cool of itself, or be quenched, they must new *trample* it, or wash it, before 'tis put into the Furnace; which is no other than an *Alman-Furnace*.

*Moor-Tin*, or such as is digged up in the *Moors*, runs or melts best with Moor-coal charred; but other Tin, which lies in the Country, runs best with an equal Proportion of Charcoal and Peat (or Moor-coals) for the first Running: but when they re-melt their Slugs, then they use Charcoal. When all is melted down, and re-melted, there sometimes remains a different Slug in the Bottom of the Float, which they call *Mount-egg*; and this is mostly an Iron Body, tho' of a Tin Colour; as was tried, by applying one of the Poles of a Load-stone to it, which it quickly attracted, tho' not so strongly as Iron.

Tho' Tin, for the most part, be made from the Stones, in which it is incorporated, yet 'tis sometimes mixed with a gravelly Earth, sometimes white, but usually red; from whence 'tis easily separated by bare *Washing*. This gravelly Tin is called *Pryan Tin*, and has scarce half the Goodness of the other.

The *Mundick Ore* is usually discovered by its Glittering, yet sad-coloured Brownness, where-with it will soon discolour their Fingers. This is said to nourish the Tin; and yet they say where much *Mundick* is found, there is little or no Tin. Certain it is, that if there be any *Mundick* left in melting the Tin, it makes it thick and curdy; that is, not so ductile as otherwise. The *Mundick* seems to be a Kind of *Sulphur*; for Fire only separates it from the Tin, and evaporates it into Smoke.

The *Cornish Diamonds* lie intermixed with the *Tin-Ore*, and sometimes on Heaps; they are hard enough to cut Glafs; and some of them are of a transparent red, and have the Lustre of a deep Ruby. They seem to be only a fine hard Spar.

The best *Tin Ore* is that which is in Sparks, and next to this, that which hath bright Spar in it. The Furnace where they melt, and from whence they cast their Tin, they call a *Blowing-House*. See also Mr. Ray's Collection of *English Words*.

TINCTURE, the Heralds call the Colours in an Escutcheon, or Coat of Arms, *Tinctures*.

TINCTURE, in Chymistry, is a Dissolution of the more fine, and volatile Parts of a mix'd Body in Spirit of Wine, or some such proper Menstruum. The Matter is bruised in a Mortar, and then put into a Matrafs, and on it the Spirit of Wine (usually) is poured to the Height of two, or three Fingers above it: Then the Glafs is close stopp'd and set in Digestion in a Sand-Heat for four or five Days, till the Spirit is well impregnated, and hath received an high Colour, or Tincture from the Matter. Thus the Tincture of Cinnamon, and all Odoriferous Vegetables are drawn.

And when Tinctures are drawn from Minerals, or Metals; this Spirit is the common Menstruum made use of.

TINNITUS *Aurium*, is a certain Buzzing, or Tingling in the Ears, proceeding from Obstruction, or something that irritates the Ear, whereby the Beating of the Arteries, and the Drum of the Ear is highly verberated; whence arises a Buzzing, or Noise.

TIP-STAVES, are the Warden of the Fleet's Officers; attending the King's Courts with a painted Staff, for taking into Custody such Persons as are committed by the Court; and to attend such Prisoners as go at large by Licence. By this Name also are the Judges Officers called, who carry a Rod, or Staff, tipped with Silver, and take charge of such Prisoners as are either committed, or turned over at the Judges Chambers.

TIRE, or, as the Seamen pronounce it, *Teer* of Guns, are a Rank of them placed along a Ship's Side, either above, upon Deck, or below: The former of which, are called the *upper Tire of Guns*; the latter, the *lower Tire*. There is also in some Ships half a *Tire* on the *Fore-decks*, and *Half-decks*.

TITE, the Seamen say a Ship is *Tight*, or *Tite*, when she is so staunch as to let in but very little Water; and this is known by the Smell of the Water pump'd out; for if she let in but little Water, it will always stink, otherwise not.

TITILLATION, is that Sensation we have in any Part of the Body when tickled.

TITLE of *Entry*, is when one seised of Land in *Fee*, makes a Feoffment thereof on Condition, and the Condition is broken; after which the Feoffer hath *Title* to enter into the Land, and may do so at his Pleasure, and by his *Entry* the Freehold shall be said to be in him presently: And 'tis called *Title of Entry*, because he cannot have a Writ of Right against his Feoffee upon Condition, for his Right was out of him by the Feoffment, which cannot be reduced with *Entry*, and the *Entry* must be for the Breach of the Condition.

TITUBATION, in *Astronomy*, a Kind of Libration or Shaking, which the ancient Astronomers attributed to the crystalline Heavens, to account for certain Inequalities they observed in the Motions of the Planets.

TMESIS, is a Figure in Grammar, whereby a compound Word hath its Parts separated from one another, by the Interposition of some other Word, as in this of *Terence*.

*Quæ meo cunque animo lubitum est facere.*

Where *Quæ* and *cunque*, are divided by putting *meo* between them.

TOD of *Wool*, is a Weight mentioned in 12 *Car. cap. 23*. containing 28 Pound, or 2 Stone Weight.

TOFT, *Toftum* in the Law signifies a Mesuage, or rather perhaps a Place where a Mesuage stood: 'Tis a Word much used in Fines.

TOISON *d'Or*, (French) the Term in Heraldry for a golden Fleece, which is sometimes born in a Coat of Arms.

TOLL, or *Tholl*, in Common Law, hath two Significations. First, It is used for a Liberty to buy and sell within the Precincts of a Manor. Secondly, For a Tribute or Custom paid for Passage, &c. Some interpret it to be a Liberty as well to take as to be free from *Toll*; for they who are Enfeoffed with *Toll*, are Custom-free.



**TOLT**, is a Writ, whereby a Cause depending in a Court-Baron, is removed to the County-Court; and is so called, because it does *Tollere loquelam*, from the one Court, to another.

**TOMENTUM**, properly signifies *Flocks*, or *Locks* of Wool; but by Botanists 'tis used for that soft Downy Matter which grows on the Tops of some Plants; which therefore are denominated from hence; as *Gramen Tomentosum*, *Carduus Tomentosus*, &c.

**TOMETICA**, [τομετικά of τέμνω, Gr. *to cut*] the same with *Attenuantia*.

**TOMICE**, the Art of Carving in Wood, or Ivory. The Artist in this Work was called *Desseſtor*.

**TOMOTOCIA**, [of τομή, Gr. *a Section*, and τόκος, Gr. *a Birth*,] the same with *Hysterotomia*. *Blanchard*.

**TOMPION**, is the Stopple of a Great Gun or Mortar, being made of Wood, and put into the Mouth, to keep out Rain; also in loading of a Mortar, there is a Tompion of Wood, which is fitted exactly to the Bore of the Piece at the Mouth of the Chamber, and this is drove in hard after the Powder, and the Bomb is placed upon it.

**TONIC**, in *Physick*, a Term apply'd to a certain Motion of the Muscles, in which the Fibres being extended, continue their Extension in such manner, as that the Part seems immoveable, tho' it is, in Reality, in Motion.

**TONDINO**, a Term in Architecture. See *Astragal*.

**TONE**, a Term in Musick, signifying a certain Degree of Elevation, or Depression of the Voice, or some other Sound. *Musicians* commonly determine it to be the sixth Part of an *Octave*, in which Sense, the *Octave* is said to be composed of Five *Tones*, and two *Semi-tones*; and the *Tone* to be the Difference between the fourth and fifth. A *Tone*, or whole Note, is divided into nine Particles, call'd *Comma's*, five of which are assigned to the greater *Semi-tone*, and four to the lesser.

**TONICA**, are those Things which being externally applied to, and rubb'd into the Limbs, strengthen the Nerves and Tendons. *Blanchard*.

**TONGUE Grafting**, is a way of Grafting in Roots, thus: The Root is cut sloping about an Inch in length, and the Graft as much, both very smooth; then each is cleft an Inch in length also, and then they are made to enter into one another, so that the Sap of the Graft may join to that of the Root as much as can be. Lap the jointed Part about with a little Hemp, or Flax Hurds, and set the Root so grafted into the Ground, about ten or twelve Inches deep, so as the Joint may be about four Inches at least covered under the Earth, that it may not be bared at any time, but kept moist by the Earth. The Root you graft on, may be a piece of the Root of an Apple or Pear-tree, about six Inches in length; it should not be less than the Graft, but it may be bigger; but 'tis best when they are both of the same size. *Vid. Philosophical Transactions*, N<sup>o</sup>. 95.

About twenty-nine Years ago, saith Mr. *Lewis*, who communicated the Method above, I sowed a Bed of Apple-kernels in *March*, the Spring following I plucked up forty of these Seedlings, grown to the thickness of a fair Graft; I grafted them in this manner of *Tongue Grafting*, and planted them again: they all grew, and four of them bear Fruit to perfection that Year; so that in a Year and a half,

from an Apple-kernel I had ripe Fruit. Some of these Trees will now bear two Quarters of Apples upon a Tree, and are bigger than most of those Trees among which they stand, which cost twelve Pence a Tree, when these were Kernels. I conceive, saith he, that Plums, Cherries, Apricocks, Peaches, and all sorts of Fruit-Trees, may be thus raised.

**TONNAGE**, is a Custom or Impost paid to the King, for Merchandise carried out, or brought in Ships, and such like Vessels, according to a certain Rate upon every Tun.

**TONSILLÆ**, the Almonds of the Ears, as they are vulgarly call'd, are two Glands seated at the Root of the Tongue, on each Side of the *Uvula*, and at the Top of the *Larynx*, covered with the common Membrane that invests all the Mouth.

Dr. *Wharton* says, That tho' they seem two, yet they are really but one, being continued to one another by a thin and broad Production, which is of the same glandulous Substance with themselves. He says, they are of a yellowish Colour, and compares their Substance to concremented Honey, only they are of a more firm Consistency, but they look sandy like it: They have small Vessels from the *Jugular Veins* and *Arteries*, and *Nerves* from the fifth Pair.

They have each a large oval common Duct, or *Sinus* that opens into the Mouth so wide in an Ox, that one may put the Tip of the little Finger into it. Into this many lesser open, and by a Discharge into the Mouth, &c. the Liquor that is separated in the Gland.

*Fallopious* hath observ'd this Aperture, or *Sinus*, to look like a small Ulcer when the Gland has been swelled, and sometimes by unskilful Persons, to have been treated as such, when it has only been forced to gap a little too much through the too plentiful Defluxion of Humours upon the Gland.

The Use of these Glands was by the Ancients supposed to be only to separate a certain mucous, or pituitous Matter from the Blood, for the moistening, and lubricating of the *Larynx*, Tongue, Fauces, and Gullet: But Dr. *Wharton*, and as many as attribute a fermentative Quality to the *Saliva*, ascribe a more noble Use to them; viz. to make a Ferment to further the Concoction of the Stomach: Yea, Dr. *Wharton* (but I think mistakingly) thinks that they are the chief Instrument of Taste.

**TOP**, of a Ship, is a round Frame of Boards lying upon the Cross-trees near the Head of the Mast: Here they furl or loose the Top-sail, &c.

**TOP-ARMOURS**, are a kind of Cloths hung about the Round-tops of the Masts for show; and also to hide the Men which are in the top in a Fight, who lie there to sling Stink-pots, &c. or to fire small Shot down on the Enemy in case of Boarding.

**TOP-GALLANT-Masts** of a Ship are two, viz. *Maintop-gallant-Mast*, and *Foretop-gallant-Mast*: And these two are small round Pieces of Timber, set on their respective *Top-masts*; on the Top of which Masts are set the Flag-staffs, on which the Colours, as Flags, Pendants, &c. hang.

**TOP-MASTS** of a Ship are Four; which are made fast, and settled into the Heads of the *Main-mast*, *Fore-mast*, *Mizen-mast*, and *Boltsprit* respectively.

**TOP-ROPES**, are those with which the *Top-masts* are set, or struck. They are reeved thro' a great Block, which is seized on one side under the Cap,



Cap, and then they are reeved thro' the *Heel* of the *Top-mast*, where is a *Brass Shiver* placed athwart Ships; after this they are brought up and fastened on either side the Cap with a Ring: The other part of them comes down by the *Ties*, and so is reeved into the *Knight-head*; and when it is to be heaved, is brought to the *Capstan*. These *Top-ropes* belong only to the *Main*, and *Fore-mast*.

**TOPHUS** [τόπος, Gr.] is a stony Concretion in any part of an Animal Body; which is also frequently called *Tophaceous Matter*.

**TOPICK** [τοπικόν, of τόπος, Gr. a Place] in Medicine signifies what is outwardly applied to the Patient's Body, to cure him of his Distemper.

**TOPICK**, in *Logick*, is a *Ground*, or *Subject* on which to found, or from whence to draw an Argument in Disputation.

**TOPINARIA**, is the same with *Talpa*. *Blanchard*.

**TOPOGRAPHY** [τοπογραφία of τόπος, a Place, and γραφή, a Description, Gr.] is a particular Description of some small quantity of Land, such as that of a Manor, or particular Estate, &c. or such as Surveyors set out in their Plots, or make a Draught of, for the Satisfaction, and Information of the Proprietors.

**TOPPING** the *Lifts*, is the same as haling the *Top-sail-Lifts*; and therefore they say *Top a Star-board*, or *Top a Port*; that is, hale upon the Star-board or Larboard Lift. See *Lifts*.

**TORCE**, a Term in Heraldry for a Wreath; which see.

**TORCULAR** *Herophili* in Anatomy, is that Place where the four Cavities of the *Dura Mater*, or Thick Skin of the Brain are joined.

**TORRE**, or *Torus* in Architecture, or as 'tis sometimes spelt *Thore*, is that round Ring which encompasses in the Column, between the *Plinth* and the *Lift*. This is the third Member of the Base of a Column; it seems like a round Cushion, swelling out with the Weight of the Incumbent Pillar.

**TORREUMATOGRAPHY** [of τορευμα and γράφω to describe, Gr.] the Knowledge, or rather the Description of ancient Sculpture, and *Basso Relievo*.

**TORREUTICE** [τορευτική of τορεα, Gr. to bore through, or of τόπος, Gr. a Lath] that part of Sculpture, called turning.

**TORRICELLIAN Experiment**, so called from its Author, and Inventor *Torricellius* an Italian; is when a Glass Tube of about 3 Foot in Length, and  $\frac{1}{4}$  of an Inch Bore being sealed (or closed in the Fire) at one end, is at the other quite filled with Quick-silver; and then being stopp'd with the Finger, hath its unsealed end thrust down under the Surface of some Quick-silver, contained in a Vessel; and then the Finger being removed from the Orifice, and the Tube put into an erect Posture, the Mercury will descend, or run out 'till it remain in the Tube, to the Height of between 28 and 31 Inches, leaving in the top of the Tube an apparent empty Space.

This Quick-silver, thus suspended, hath been found to encrease or lessen its Height in the Tube, according as the Weather alters for dry or wet; and therefore when hung in a Frame with a Plate of Divisions for this purpose, 'tis called the Quick-silver Weather-glass, the *Mercurial Barometer*, or *Baroscope*; which Words see.

That the Cause of the Suspension of the Mercury in this Tube, is occasioned by the Weight of

the Atmosphere incumbent on the Orifice of the Tube, and the stagnant Mercury in the Bason over it, is the received Opinion, and seems proved by these Experiments and Reasons.

First, That when a Tube, in which this *Torricellian Experiment* is duly made, is placed (Cistern and all) in the Receiver of the Air-pump; after one Suction the Mercury will descend, and so still will it go lower and lower at every Suction of the Air out, 'till at last the Surface of the Mercury within the Tube, will be a very little higher than that which is in the Bason: But as soon as the external Air is let into the Receiver again, it will by its Spring (which is always equal to the Gravity of the Atmosphere) so press on the Surface of the Mercury in the Cistern, as to force it up again into the Tube with such Violence as will endanger breaking it, and it will (when quiet) regain near its former Height in the Tube.

2. It hath been found by repeated Trials, that the included Mercury will sink if the Tube be carried up to the Top of an high Hill, or up but to the Top of an high Tower, Steeple, &c. the Reason of which appears to be, that the Column of incumbent Air which pressed upon it before, being now lessen'd in Length by the Altitude of the Hill, must needs gravitate less than at the Bottom, and consequently cannot bear the Mercury up so high in the Tube. And this Mr. *Boyle* takes to be a Kind of *Experimentum Crucis*, determining plainly the Cause of the Mercury's Suspension.

3. If after the Experiment is made, and the Mercury settled, you lift the Tube out of the stagnant Mercury, the external Air will press in with that Violence, and drive the Mercury up to the Top of the Tube so forcibly, as will endanger the breaking out of the sealed End.

**TORNADO**, is the Name given by the Seamen for a violent Storm of Wind, and sometimes followed by Rain; it usually swiftness or turns about to almost all Points of the Compass, whence I suppose its Name.

**TORRENT**, in *Geography*, an impetuous Stream of Water, which falls suddenly from Mountains wherein great Rains have been, or an extraordinary Thaw of Snow.

**TORRID Zone**. See *Zone*.

**TORRIFIED**, i. e. Roasted, it was formerly the usual way to *Torrefie* Opium, or roast it against the Fire, before any Medicinal Preparation was made with it, in order to get out some malignant Parts that they fancied were in it before: But by this Means its volatile Spirits and Sulphur in which its great Virtue consists were evaporated and destroyed. And indeed 'tis found by Experience, that in most Cases *Crude Opium* is better than any other Preparation of it whatsoever.

**TORT**, is a *French Word*, signifying *Wrong or Injury*, and is often used in our Law; as, *de son Tort*, is in his own Wrong.

**TORTEAUXES**, a Bearing in Heraldry. See *Balls*.

**TORUS**, in Architecture, is a round, thick Circle running round the Base of a Pillar, resembling the Form of a great Ring.

**TOTTED**, a good Debt to the King, is by the foreign Opposer, or other Officer, noted for such, by writing this Word *Tot* to it.

**TOUCAN**,



**TOUCAN**, in *Astronomy*, a Constellation of the Southern Hemisphere.

**TOUT** *temps prist & uncore est*, is a kind of a Plea in way of Excuse, or Defence for him that is sued for any Debt, or Duty belonging to the Plaintiff.

**TOW**, whatever is drawn after a Ship, or Boat with a Rope, &c. is said to be *Towed* after a Ship, or to be in her *Tow*.

**TOXICA** [τοξικά, Gr.] are poisonous Medicaments, wherewith *Barbarians* use to anoint their Arrows. *Blanchard*.

**TRABEATION**, in *Architecture*, is the same with *Entablature*, viz. the Projecture on the Top of the Walls of Edifices which supports the Timber Work of the Roof. *Trabeation*, or *Entablature*, is different according to the several Orders, and comprehends the Architrave, Frize, and Cornice.

**TRACHEA**, the same with *Aspera Arteria*; which see.

**TRACHOMA** [τράχωμα, Gr.] is a Scab, or Asperity of the inner Part of the Eye-lid. *Blanchard*.

**TRACTION**, the Action of a moving Power, whereby the moveable Body is brought nearer to the Mover, called also *Attraction*.

**TRACTRIX**, in *Geometry*, a Curve Line, the same that is called *Catenaria*.

**TRAFINE**, in *Surgery*, *Atrepan*.

**TRAGEÆ**, a Term in Pharmacy; the *Trageæ* differ not from Powders, but that the Ingredients whereof they are prepared, are not beat so small: And they are applied either in Fumigations, or externally to the Body, by being put into a Linnen Bag, and then into Wine or other Liquor, that they may communicate their Strength, and Qualities to it: Sometimes also they are compounded of some sorts of Antidotes, or Counter-poisons, and other odoriferous things, and of simple Medicines reduced into a Powder, with an Addition of Sugar, in order to be taken inwardly. *Blanchard*.

**TRAGUS** [τράγος, Gr.] as *Hircus* (because 'tis sometimes hairy) is one of the Protuberances of the *Auricula*, being that next the Temple, as that which is opposite to it, and to which the soft Lobe of the Ear is annexed, is called *Antitragus*.

**TRAJECTORY**, of a Comet, is the Line which by its Motion it describes; which *Hevelius* in his *Cometagraphia*, will have to be nearly a Right one; but it seems rather to be a very eccentric Ellipsis.

The Excellent Sir *Isaac Newton*, in *Prop. 41.* of his third Book, shews how to determine the Trajectory of a Comet from three Observations; and in his next and last Proposition, how to correct a Trajectory graphically described. See *Comets*.

**TRAILE-BOARD**, in a Ship, is a carved Board on each side of her Beak, reaching from her main Stem to the Figure, or to the Brackets.

**TRAIN**, is the Number of Beats which the Watch maketh in an Hour or any other certain Time.



**TRANCHE**, a Word used by the *French* Armorists, to express a manner of *Counterchanging* in an Escutcheon of this Form.

But our *English* Heralds Blazon it thus; he beareth, *Per Pale, Argent and Azure, per Bend Counterchanged*.

**TRANGLE**, in *Heraldry*, the Diminutive of a *Fesse*, commonly called a Bar.

**TRANSCENDENTAL Curves**, are such, as when their Nature, or Property comes to be expressed by an *Equation*, one of the variable, or flowing Quantities there, denotes a *Curve Line*; and when such *Curve Line* is a *Geometrick* one, or one of the *first Degree*, or *Kind*; then the *Transcendental Curve* is said to be of the second *Degree* or *Kind*, &c.

**TRANSCENDENTAL Quantity**. See *Quantity*.

**TRANSCENDENTAL Quantities**, Mr. *Leibnitz*, in the *Act. Erud. Lipsiæ*, for June 1686, hath a Dissertation, in which he proposes to shew the Origin and Rise of such kind of Quantities, viz. Why some Problems are neither *Plain*, *Solid*, nor *Sur-solid*, nor of any certain Degree, but do transcend all Algebraical Equations: As also to shew how it may be demonstrated without a *Calculus*, that an *Algebraical Quadratrix* for the *Circle* or *Hyperbola* is impossible. For if such a *Quadratrix* could be found, it would follow, that by the help thereof, any *Angle*, *Ratio*, or *Logarithm*, might be divided in the given Proportion of one Right-Line to another; and this by one *universal Construction*. And consequently, the Problems of the *Section of an Angle*, or the *Invention* of any number of mean Proportionals, would be of a *certain Degree*. Whereas the different Numbers of Parts of an Angle, or of mean Proportionals, do necessarily require *different Degrees* of *Algebraical Equations*. And therefore the Problem, understood in general of any Number of Parts of an Angle, or mean Proportionals, is of an *indefinite Degree*, and *transcends* all *Algebraical Equations*.

However, since such Problems as these may really be proposed in Geometry (nay, and ought to be reckoned amongst the most principal) and besides are *determinate*; therefore 'tis necessary that such Lines should also be received into Geometry, as are alone sufficient for the Construction of these Problems.

And further, since they may be described exactly by a *continual Motion* (as is apparent in the *Cycloid*, &c.) they ought not to be accounted *Mechanical*, but *Geometrical Curves*; especially too, since they are of much greater use than all the Lines of the common Geometry (except the Right-Line and Circle) and have also some very important Properties, which are altogether capable of Geometrical Demonstration.

*Des Cartes* therefore was no less out in excluding these from Geometry, than the Ancients were, who neglected the *Loca Solida & Linearia*, as not Geometrical.

Now, because the Method of discovering *indefinite Quadratures*, or their *Impossibilities*, is with me but a particular Case (and indeed an entire one) of a much sublimer Problem, which I call the *Inverse Method of Tangents*, in which the greatest part of the whole Transcendental Geometry is contained; and which, if it could be always Algebraically solved, all that is wished for would be done; since also I find nothing satisfactory, as yet, extant about it: I will now shew you how this may be done, as well as the *Indefinite Quadrature itself*.

Whereas then Algebraists used before to assume some *general Letters*, or Numbers for the Quantities sought, I (in these Transcendental Problems) assume *General or Indefinite Equations*, for the Lines sought.



sought. *Ex. gr.* putting  $x$  and  $y$  for the *Abscissa* and *Ordinate*, the Equation I use for a Line sought, is,  $a + bx + cy + exy + fxx + gyy$ , &c.  $= 0$ . By the help of which indefinite Equation (which in reality is *finite*; for it may always be determined, how far soever 'tis necessary to raise it) I enquire the Tangent, and that which results comparing with the given Property of Tangents, I find the Value of the assumed Letters,  $a, b, c$ , &c. And thus I define the Equation of the Line sought.

In which Equation, sometimes there are some things which remain *Arbitrary*, and in that Case innumerable Lines may be found that will satisfy the Problem.

And this was the Reason that a great many, observing the Result, believed the Problem not to be *sufficiently determined*, nor indeed *possible*. The same things are also done by *Series*: but with respect to the *Abridgment* of the *Calculus*, I have several helps; of which, more in some other place.

Now, Lastly, if the *Comparison* above-mentioned doth not proceed, I pronounce the Line sought, not to be an *Algebraical*, but a *Transcendental* one.

This supposed, the next Work is to find the *Species of the Transcendency*; for *some Transcendentals* depend on the general Division or Section of a *Ratio*, or upon the Logarithms; *others* upon the Arks of a Circle; and *others* on more *indefinite* and *compounded Enquiries*.

Here therefore, besides the Symbols  $x$  and  $y$ , I assume a third, as  $v$ , which denotes the Transcendental Quantity; and then of these three, I form a general Equation for the Line sought, from which I find the Tangent (according to my Method, which proceeds even in Transcendental Quantities;) then what I find, I compare with the given Properties of the Tangents, and so discover not only the Values of  $a, b, c$ , &c. but also the particular Nature of the Transcendental Quantity.

And though it may sometimes happen, that the several *Transcendents* are so to be made use of, and those of different Nature too from one another; also though there be *Transcendents of Transcendents*, and a Progression of these *in infinitum*, yet we may be satisfied with the most easy and useful one, and for the most part, may have recourse to some peculiar Artifices for shortning the *Calculus*, and reducing the Problem to as simple Terms as may be.

Now this Method, applied to the Business of *Quadratures*, or to the Invention of *Quadratrices* (in which the Property of the Tangent is always given) 'tis manifest, not only how it may be discovered, whether the indefinite Quadrature be *Algebraically* impossible, but also how (when this Impossibility is discovered) a *Transcendental Quadratrix* may be found, which is a thing which has not yet been shewn. So that it seems, I may without vanity assert, that Geometry is by this Method carried infinitely beyond the Bounds, to which *Vieta* and *Des Cartes* brought it: Since, by this means, a certain and general Analysis is established, which extends to all these Problems, which are of no certain Degree, and consequently are not comprehended within *Algebraical Equations*.

Again, in order to manage Transcendental Problems (wherever the Business of Tangents or Quadratures occurs) by a *Calculus*, there is hardly any that can be imagined shorter, more advantageous or universal, than my *Differential Calculus*, or

*Analysis of Indivisibles and Infinites* (a very small Specimen of which, is contained in my *Method of Tangents*, formerly published.) From this *Calculus* may be derived all those Theorems and Problems that have been so much admired; and this with so much ease too, that there is now no more need of their being learned and kept in memory, than for a Man that understands Algebra to learn a great many of the Propositions of the common Geometry.

Thus, for Example, in that Theorem of Dr. Barrow's, *That the Sum of the Intervals between the Ordinates and Perpendiculars to the Curve, taken in, and applied to the Axis, is equal to the Semi-Square of the last Ordinate*.

Let the Ordinate be  $x$ , the Abscissa  $y$ , the Interval between the Ordinate and Perpendicular  $p$ ; it appears presently, by my Method, that  $p dy = x dx$ , which *Differential Equation*, turned into a *Summatory* one, makes  $S p dy = S x dx$ . But, from what I have shewn in the Method of Tangents,  $d\frac{1}{2}xx = x dx$ ; therefore contrarily,  $\frac{1}{2}xx = S dx x$  (for as in the vulgar *Calculus*, Powers and Roots are reciprocal; so in this, Sums and Differences, viz.  $S$  and  $d$  are reciprocal.) It follows therefore, that  $S p dy = \frac{1}{2}xx$ . Q. E. D.

In the Notation I had rather make use of  $dx$ , and such like Symbols, to denote the differential Quantities, than other Letters, because that Expression  $dx$ , is a certain Modification of  $x$ : And so by this means it comes to pass, that the Letter  $x$  alone (when 'tis necessary) together with its Powers and Differentials, enters the *Calculus*, and the Transcendental Relations between  $x$  and any other are expressed.

In the same Method we may also explain the Nature of Transcendental Lines by an Equation; *ex. gr.* Let  $a$  be the Ark of a Circle, and  $x$  the Versed Sine; then will  $a = \frac{S dx}{\sqrt{2x - xx}}$ ; and

if the Ordinate of the Cycloid be  $y$ , then will  $y = \sqrt{2x - xx} + \frac{S dx}{\sqrt{2x - xx}}$ ; which Equa-

tion perfectly expresses the Relation between the Ordinate  $y$ , and the Abscissa  $x$ ; and from it all the Properties of the Cycloid may be demonstrated.

And thus is the Analytical *Calculus* extended to those Lines which have hitherto been excluded, for no other Cause, but that they were thought incapable of it.

Also Dr. Wallis's Interpolations, and innumerable other things, are derived from hence.

As to what remains, that I may not seem to ascribe too much to myself, or to detract too much from others, I will briefly shew what seems to me to be due to the chief Mathematicians of our Age, with respect to this kind of Geometry.

First of all, *Galilæus* and *Cavallerius* began to explain the most involved Methods of *Conon* and *Archimedes*; but *Cavallerius's* Geometry of Indivisibles was no more than the Infancy of the Science: Greater Improvements were made yet by those three famous Persons, Mr. *Fermat*, in his *Method de Maximis & Minimis*; *Des Cartes*, by shewing how to express the Lines of vulgar Geometry (for he excluded the Transcendental ones) by Equations; and *Gregory St. Vincent*, by several noble Discoveries; to which I add *Guldinus's* admirable Rule about the Centre of Gravity. But all these



stopped within certain (comparatively) narrow Bounds, which the famous Geometers, Mr. *Huygens* and Dr. *Wallis*, went beyond, opening new Ways. For 'tis probable enough, that *Huygens's* Inventions gave rise to that of *Haureet*; as those of *Wallis* might to those of *Neil* and *Wren*, who were the first that rectified Curve Lines, and this without any Detraction from the just Praise of these noble Discoverers. These were followed by Mr. *James Gregory*, and Dr. *Isaac Barrow*, who wonderfully increased the Science with admirable Theorems of this kind. In the mean Time, Mr. *Nicholas Mercator*, a *Holsatian*, and most excellent Mathematician, was the first that I know of, who exhibited any Quadrature by an infinite Series. Which Invention that profound Geometer, Sir *Isaac Newton*, did not only reach by himself, but also compleat, by an universal Way; and would he make publick the Thoughts he has yet further on this Subject, he would certainly open new ways to us, to the great increase, and yet abridgment of the Science. As for myself, it happened when I was yet but a *Tyro* in these Studies, that the sight of a certain Demonstration concerning the Magnitude of a spherical Substance, suddenly gave me some Light; for I saw in general, that the Figure made, by applying the Perpendicular to the Curve, as *Ordinates* to the *Axis* (which Perpendiculars in the Circle are the *Radii*) was proportional to the Surface of the Solid, generated by the Rotation of the Figure about the *Axis*. With which first Theorem being wonderfully delighted, and not knowing that the same was known to any one else, I presently invented a Triangle, which in every Curve I called the *Characteristick Triangle*, the sides of which should be *indivisible* (or speaking more properly) *infinitely small* or *differential Quantities*; from whence I presently, and with ease, derived a vast *Copia* of Theorems, part of which I found afterwards in *Barrow*, and the *Gregories*. And as yet I made no use of an *Algebraical Calculus*, which when I did apply, I soon after found my Arithmetical Quadrature and several other things. But, I know not how, an Algebraical Calculus did not satisfy me in this Business, and I was forced to do a great many things (that I had a mind to in the Analytick way) by long *Ambages* of Figures, 'till at last I found out the true *Supplement of Algebra* for *Transcendental Quantities*; viz. my *Calculus infinitus parvorum*, which I also call the *Differential, Summatory, or Tetragenistick Calculus*: And, if I am not mistaken, aptly enough, the *Analysis of Indivisibles* and *Infinities*. Which Method, once discovered, all those things which I formerly had so much admired in this kind, seemed meer Play and Sport to me. For from hence I was able, not only to find out admirable *Compendiums*, but also to attain that most universal Method above explained; by the help of which, either *Quadratrices*, or any other Lines sought, whether *Algebraical* or *Transcendental*, are determined as far as is possible.

Before I conclude, I would yet add this one Caution, that in managing *Differential Equations*, such as this before mentioned,  $a = \frac{S dx}{\sqrt{2x - xx}}$ ,

a Man should not rashly neglect the  $dx$  on this account, that it may be neglected when the  $x$  are taken as increasing uniformly: For by this means a great many have gone wrong, and precluded the Way to themselves, in not allowing the Dif-

ferentials, as  $dx$ , their own Universality: So that the Progression of the  $x$  might be assumed at liberty. Whereas from this one thing alone arise innumerable Transfigurations and Equipollencies of Figures.

TRANSCRIPT, *Anno* 34 and 35 *Hen. VIII. Cap. 14.* is the Copy of any Original, written again, or exemplified; as the Transcript of a Fine.

TRANSIRE, 14 *Car. II. Cap. 11.* is the Term given in the Custom-house to a Warrant or Pass, to let Goods be removed from place to place.

TRANSMUTATION: Sir *Isaac Newton*, at the end of this Book of *Opticks*, *Edit. Lat.* seems to be of opinion, that *Crasse*, or thick *Bodies*, and *Light* may be mutually converted and transmuted into one another; and that all Bodies receive their active Force from the Particles of *Light* which enter into their Composition. For all fixed Bodies, when well heated, emit *Light* as long as they continue so: And on the other hand, *Light* intermingles itself, and inheres in Bodies as often as its Rays fall upon the solid Particles of those Bodies, as he shews before. There is no one Body (saith he) which is less apt to shine than *Water*: But yet *Water*, as Mr. *Boyle* found by repeated Distillations, is capable of being transmuted into a fixed Earth; and that Earth will be capable of bearing Heat enough to be made by that means to emit *Light*, and shine as well as other Bodies. And he thinks this mutual Transmutation of Bodies and *Light* into one another, to be very agreeable to the Order of Nature, which seems to delight in such Transmutations.

*Water*, which is a Salt very fluid, volatile, and tasteless, is by Heat changed into *Vapour*; which is a kind of Air; and by Cold, into *Ice*, which is a hard, transparent, fragile Stone, easily meltable; and this Stone is convertible into *Water* again by Heat, as *Vapour* is by Cold. *Earth*, by Heat, becomes *Fire*, and by Cold is turned into Earth again. *Dense Bodies*, by Fermentation, are rarified into various kinds of Air; and that Air, by Fermentation also, and sometimes without it, reverts into dense Bodies again. *Quick-silver* sometimes puts on the form of a fluid Metal, sometimes of a hard and fragile one: Sometimes it appears in the shape of a pellucid and fragile Salt, which they call *Sublimate*; and sometimes in that of a pellucid, volatile, tasteless white Earth, which is called *Mercurius Dulcis*: Sometimes it looks like a red, opaque, and volatile Earth, and then 'tis called *Cinnabar*: Sometimes 'tis in the form of a red, and sometimes of a white *Precipitate*, and sometimes of a fluid Salt: By Distillation it becomes a *Vapour*, and by Agitation in *Vacuo*, it shines like Fire. And yet after all these, and many other Changes, is capable of being brought back again into running Mercury. The Eggs of Insects, &c. as far as Sense can judge, are by little and little evolved, explicated, and encreased in Magnitude, and so turn'd into Animals; Tadpoles are turned into Frogs; little Worms, or Maggots, into Flies.

All Birds, Beasts, Fishes, Insects, Trees, and Plants, with all their so very different Parts, grow and encrease out of *Water*, and aqueous and saline Tinctures; and on Putrefaction, all of them revert into *Water*, or an aqueous Liquor again. Moreover, *Water* exposed a while to the open Air, puts on a Tincture, which (like the Tincture of Barley, macerated without boiling) in process of



of Time hath a Sediment and a Spirit, and before Putrefaction, yields Nourishment both for Animals and Plants. Now among all these many various and wonderful Transmutations, why should not Nature turn *Light* into *Bodies*, and *vice versa*?

The great Objection against the practical Transmuting of a baser Metal into a nobler, seems to be, that the specifick Gravities of Metals cannot be altered: But in Dr. *Hook's* Life; before his *Opera Posth.* I find, that Dr. *Hook*, in 1679, is said to have made some Experiments about the mixing of Metals; and particularly, that in a Mixture of Copper and Tin, the specifick Gravity of the Compositum was *really increased*; for that of the Copper was  $8\frac{1}{2}$  to one, and that of Tin but  $7\frac{1}{3}$  to 1; and yet that of the Mixture was  $8\frac{3}{4}$  to 1.

TRANSCRIPTO *pedis finis levati mittendo in Cancellarium*, is a Writ for the certifying the Foot of a Fine, levied before a *Justice in Eyre*, &c. into the *Chancery*.

TRANSCRIPTO *Recognitionis factæ coram Justiciariis itinerantibus*, &c. Is a Writ for the certifying of a Recognizance, taken before *Justices in Eyre*, &c. into the *Chancery*.

TRANSFORMATION of Curves.

The Abbot *Galloys* of *France*, having in the Year 1693, maintained, that Mr. *James Gregory*, and our excellent Dr. *Barrow*, had borrowed their general Propositions about the Transformation of Curves from Mr. *Roberval*; Dr. *David Gregory*, Astronomy Professor in *Oxon*, doth in *Philosophical Transactions*, N<sup>o</sup>. 214. pag. 233. fully refute that Assertion, by shewing that Mr. *James Gregory's* Book was published at *Padua*, 1668; and Dr. *Barrow's* *Lectiones Geometr.* 1674. And therefore 'tis more than probable, that Mr. *Roberval* had seen those Books, since he did not die 'till Oct. 1675; and yet we find not that he makes any such Complaint.

TRANSFUSION of the Blood, out of one Animal into another, is thus performed: Bind and lay them both down on a Table, and then making strong Ligatures round each of their Necks, open the *Right Jugular Vein* and *Carotid Artery* of the Man (if you can get one to try) and the *Left* of the Sheep, &c. (or *vice versa*;) Then dextrously fitting two small Quills, or Pipes, cross-ways from Vein to Artery, so that the Arterious Blood of the Sheep may run into the Veins of the Man, and the Venal Blood into his Arteries, the Sheep receiving his after the same manner: And when the rational and sagacious Looks of the Sheep, and the sheepish ones of the Man begin to appear plainly distinguishable, the Operation is well over; separate them and bind up their Wounds, and 'tis done.

Of this *Transfusion* (if any one hath a fancy to try it) he may find a more large Account in *Philosoph. Transact.* N<sup>o</sup>. 20.

'Twas first (as is said) practised by Dr. *Lower*; and by the Honourable Mr. *Boyle* communicated to the *Royal Society*.

And in N<sup>o</sup>. 26. pag. 479. of *Philos. Transact.* there is an Account, that one Mr. *Gayant* of *Paris*, by Transfusing the Blood of a young Dog into an old one that was exceedingly Decrepid, and bare his Age very poorly, made the old Curr so lively and brisk, that in two Hours after the Operation was over, he leapt and frisked about with very youthful Agility.

*So that, Transfusion of the Blood,  
Which makes Fools Cattle, did him good.*

HUDIBRAS.

TRANSGRESSIONE, is a Writ commonly called a Writ or Action of Trespass, of which *Fitz-Herbert* reckons two sorts: one *Viscountiel* so called, because it is directed to the Sheriff, and is not returnable, but to be determined in the County; the Form whereof differs from the other, because it hath these Words, *Quare vi & armis*, &c. The other is termed a Writ of *Trespas* upon the Case, which is to be sued in the King's-Bench, or Common-Pleas, in which are always used these Words, *vi & armis*. See *Trespas*.

TRANSIT, in *Astronomy*, signifies the passing of any Planet just by or under any fixed Star; or of the Moon in particular, covering or moving close by any other Planet.

TRANSITION, in *Musick*, is when a greater Note is broken into a lesser, to make smooth, or sweeten the roughness of a Leap, by a gradual *Transition*, or passing to the Note next following: whence it is commonly called, *the breaking of a Note*, being sometimes very necessary in musical Compositions.

TRANSITIVE, in *Grammar*, an Epithet given to those which signify an Action that passes from the Subject, that does it to or upon another Subject that receives it.

TRANSLATION, in *Law*, signifies the setting from one Place to another, as to remove a Bishop from one Diocese to another, is called Translation, and such a Bishop Writes not *Anno Consecrationis*, but *Anno Translationis nostræ*.

TRANSMISSION, in *Opticks*, the Act of a transparent Body passing the Rays of Light thro' its Substance, or suffering them to pass; which is the opposite of Reflexion.

TRANSMUTATION, in *Geometry*, is to reduce, or change one Figure or Body into another of the same Area, or Solidity, but of a different Form, as a Triangle into a Square; a Pyramid into a Parallelopiped, &c.

TRANSMUTATION of Metals, is what the Alchymists call the *grand Operation*, or finding the *Philosophers Stone*; which is such a curious universal Seed of all Metals, that if you melt any Metal in a Crucible, and then put in but a little of this *Stone* or *Powder of Projection* (as they often call it) into the melted Metal, it will immediately (as they tell you) turn it into Gold, or Silver, according as they use it.

The Famous Dr. *Dickinson*, in his Book *de Quintessentia Philosophorum*, tells the World, he was twice shewed this mighty Feat, by an *Adept* that went by the name of *Mundanus*: To which I shall only say, as Mr. *Boyle* used to do in such Cases, *he that hath seen it, hath more Reason to believe it than he that hath not*.

You have in *Lemery*, Dr. *Dickinson*, and others, long Accounts of the Impostures and Cheats of several pretended *Adepti*: How they fix *Mercury* with *Verdegrease*, and then Colour it deeper (for the *Verdegrease* will give it a yellow Colour) with *Turmeric* *Cadmia*, &c. and then they would pass it thus off for true Gold: But if you should go about to try it by the *Copple*, it will all fly away in Fumes. And indeed nothing produced this way ought to be adjudged true Gold (unless it have



have all the Properties of true Gold, for all is not so that glitters, and looks yellow) that is, it must be able to endure *Coppelling*, *Cementation*, *Purification* with *Antimony*, and the *Depart*. It must have the *Malleability*, and great *Ductility* of that Metal; and especially its *true Specifick Gravity*, i. e. it must be to Water, as 19, or 18 and  $\frac{1}{2}$  is to 1, or else 'tis some way false and counterfeit. And this last Test of Specifick Gravity, would, if not attainable, argue an apparent Impossibility of Transmutation of Metals. Nor indeed can I see how any one can propose to increase the Relative, or Specifick Gravity of any Body whatsoever by a certain and determinate Way; and 'till this is done, all other Pretences are in vain; for let it look how it will, if it have less Specifick Gravity than 18 and a half to 1, it cannot be true Gold; and therefore must either be a mixture of some Gold and other Metals together; or else some of them under the disguise of Gold.

The Trick of turning Cinnabar into Silver, is pretty enough, and ought to be known.

They bruise the Cinnabar grossly, and then *stratify* it in a Crucible with granulated Silver: The Crucible is placed in a great Fire, and after due time for its Calcination, they take it off; and pouring the Matter out, they shew the Cinnabar turned into real Silver, tho' the Silver Grains appear in the Number and Form they were put into the Crucible. But the Mischief of all is, when you come to handle the Grains of Silver, you find them nothing but light friable Bladders, which will crumble to pieces between your Fingers: The Silver is almost all of it got in and incorporated with the *Cinnabar*, and the whole weighs no more, nor indeed so much, as it did when it was first put into the Crucible.

But to give you something on the behalf of *Transmutation*, Mr. Boyle talks of his own separating from common Mercury, near a fourth part of its Weight in clear Liquor, *Scep. Chym. p. 134.* and tells us also, that two Friends of his did, by pressing Mercury in a skilfully managed Fire, turn it almost Weight for Weight into Water; but they tell us not in either Experiment, the Specifick Gravity of the produced Water, nor of the remaining untransmuted Mass of Mercury; which unless one knew, there is no judging of the Reality of the *Transmutation*.

In his *Second Essay on the succeeding Experiments* he tells us, that Dr. K. a Person far both from the Temptation and Custom of Lying, assured him he did once light on a kind of *Aqua-fortis* with which he did divers times draw a *Volatile Tincture*, which could and did turn Silver into Gold; and that out of an Ounce of Gold he drew as much of this Tincture, as did transmute an Ounce and a half of Silver into that noble Metal: But withal, that designing afterwards to prosecute this surprising Experiment further, he could never again make such an *Aqua-fortis* as would draw any such Tincture from Gold: Tho' Mr. Boyle seems inclined to believe the Thing possible, because he himself more than once was able to deprive Gold of its yellow Colour, and to communicate it to a *Menstruum*.

He tells us also in his *Origin of Forms, P. 235.* That by putting to a Calx of Gold, a good Portion of his *Menstruum Peracutum*, with a little Spirit of Salt, it did slowly, and quietly dissolve it, only at the Bottom remained a white Powder which the Menstruum would not touch, and which was indissoluble in *Aqua-Regalis*. This white Powder being with Borax, or some such flux Powder, melted into a Metal, was found to be white like Silver, yielding to the Hammer, dissoluble in *Aqua-fortis*, or Spirit of Nitre; and would there leave a true Silver Calx, odiously bitter. This is a strange Experiment, which had Mr. Boyle made any more than once, as I cannot find that he had; and had he tried the Specifick Gravity of this apparent Silver, and found it to be less than that of Gold, it had been no small Proof of the Possibility of a Transmutation of Metal.

But what that noble Author relates in another Place of the same Book, about the Transmutation of Water into Earth, I judge the more considerable, because he made use of Hydrostaticks, to examine his Transmuted Matter, viz.

That Rain-Water being distilled, or re-distilled (by a Friend of his) many times over again (near 200 times) did, after each Distillation, leave at the Bottom of the Glass Body, a *white Earth* in a considerable Quantity; and this was afforded (saith Mr. Boyle) more plentifully in the *latter* Distillation than in the *first*.

This he believed to be a certain Quantity of Water actually turned into Earth, and it was above twice as heavy (specifically) as common Water, and was of so fixt a Nature, that it lay in a red hot Crucible for a considerable Time, without being diminished in Weight, or emitting any manner of Smoak.

He takes notice also, that an Ounce of Water yielded six Drams of Powder, a considerable Quantity of Water still remaining behind; and that the Glass in which it was distilled, was not in the least sensibly damaged thereby. Yet this great Chymist was not without some Scruples about the Experiment. For,

First, He was not satisfied that the remaining Water was not Lighter than before the Distillation.

Secondly, He was not assured that no Parts of the Glass Vessel were dissolved, or incorporated with it.

Thirdly, Nor whether Water be truly an Homogeneous Body; for if it be, he thinks it difficult, if not impossible, to conceive that it can be transmuted: For how can (saith he) the bare Convention of the Parts of a Fluid into a Concrete, alter the Specifick Gravity.

TRANSNOMINATIO. See *Metonymia*.

TRANSOM, is the Term which some give to the Vane of a *Cross-staff*, which is made to slide along upon the *Cross-staff*, by means of a Square Socket; and may be set to any of the Graduations on the Staff, in an Observation.

TRANSOM of a Ship, is that main Piece of Timber which lieth across her Stern at her Buttock, directly under the Gun-room Port; as when a Ship



a Ship is built broad or narrow at her Transom, she is said to have a broad or narrow Buttock.

TRANSOM, in Architecture, is a Piece of Timber which is framed a-cross in a Double-Light Window.

TRANSPARENT, or Diaphanous Bodies, are such whose Pores probably are all right and nearly Perpendicular to the Plane of their Surface, and so consequently do let the Rays of Light pass freely thro' them, without being refracted: Whereas the Pores of *Opacous Bodies* are in crooked oblique Position, by which means the Beams of Light cannot pass freely thro' them, but are variously refracted and lost.

TRANSPARENT, the opaque Bodies that are, if their Parts be subtilly divided (as Metals when dissolved in Acids, &c.) become perfectly *Transparent*; from whence, and from some other Reasons, Sir *Is. Newton*, in his Opticks, concludes, That Water, Salt, Glass, some Stones, &c. and such like Substances, are Transparent, because tho' they may be as full of Pores or Interstices between their Parts, as other Bodies; yet their Parts and Interstices are too *small to cause Reflexions in their common Surfaces*. He shews also, that the least Parts of all natural Bodies are in some measure transparent; and that their Opacity arises from the Multitude of Reflexions caused in their internal Parts. 'Tis plain also, as he shews, that opaque Substances are rendered transparent, by filling their Pores with any Substance of equal, or almost equal Density with their Parts.

Thus Paper dipped in Water or Oil, the *Oculus Mundi* Stone steep'd in the former of those Liquors, Linnen-cloth oiled or varnished, and many other Substances soaked in such Liquors as will intimately pervade their little Pores, become more transparent by that means than they were before.

And the true Reason why all opaque Bodies, when reduced into very small Parts, become transparent, is, because the Thickness of the Particles being *much less* than the Intervals of the Fits of easy Reflexion and Transmission of the Rays of Light, the Body loseth its reflecting Power; for if the Rays, which at their entering into the Body, are put into Fits of easy Transmission, arrive at the furthest Surface of the Body before they be out of those Fits, they must be transmitted.

TRANSPARATION, a Breathing through, as of Vapours through the Pores of the Skin. *Blanchard*.

TRANSPLANTATION, in *Natural Magick*, is a Method of curing Diseases by transferring them from one Subject to another.

TRANSPOSITION of Equations. See *Equations*.

TRANSVERSALIS *Colli*, is a Muscle of the Neck, which riseth Fleishy from all the Transverse Processes of the *Vertebrae* of the Neck, except the first and second, and is inserted after an oblique ascending Progress to their Superior Spines; it being a Continuation of the same Series of Muscular *Fibres* that compose the *Sacer* and *Semi-spinalis*: If either of those *Muscles* act, the *Vertebrae* of the Neck are moved obliquely backwards, as when we look over one Shoulder.

TRANSVERSALIS *Musculus*, one of the Muscles of the Abdomen, so called, because its *Fibres* run a-cross the Belly: Its Use is to compress the Abdomen exactly inwards, in *Expiration*.

TRANSVERSALIS *Pedis*, is a Muscle of the Foot, so called from its Transverse Situation; it arises Tendinous from the Internal *Os Sesamoides* of the Great Toe, and becoming a Fleishy Belly in its Progress over the first Internodes of the two next Toes, it is lessened at its Insertion to the Inferior Part of that *Metatarsal* Bone, which supports that Toe next the lesser. Its Use is to bring the lesser Toe towards the greater.

TRANSVERSALIS *Pedis*. Dr. *Douglas*, in his comparative Description of the Muscles, saith, that *this* is only Part of the *Musculus accelerator Urinae*, arising from the Knob of the *Ischium*; for it is not inserted into the *Cavum Ovale*, or Bulb of the *Urethra*, but joins in with the *Accelerator*, of which it makes a second Beginning.

TRANSVERSALIS *Penis*, is a Pair of Muscles arising near the *Erectores Penis*, and thence pass transversely to their Insertions at the upper Part of the Bulb of the Cavernous Body of the *Urethra*: They have this Name for their Situation. They are mentioned by *Lindanus* after *Aquapendens*, as *Bartholin* observes, *Lib. 1. cap. 24*.

TRANSVERSALIS *Sutura*, is a Suture which runs across the Face; it passes from one Temple to another transversely, over the Root of the Nose, joining the *Os Frontis*, and the *Sinciput*: 'Tis the first of the true Sutures, and is usually called, *Coronalis*.

TRANVERSE, [*Transversus*, L.] going a-cross from Right to Left, or from Corner to Corner.

TRANVERSE *Axis*, or *Diameter*. See *Latus Transversum*.

TRANVERSE *Muscles*, in *Anatomy*, are certain Muscles that arise from the Transverse Processes of the *Vertebrae* of the Loins.

TRAPEZIUM, [*τραπέζιον*, Gr.] see under *Quadrilateral Figures*. For its Superficial Content, See *Area*.

TRAPEZIUS, is a Muscle of the Shoulder-blade, which serves to move it upwards, backwards, and downwards.

TRAPEZOID, is a solid irregular Figure, having four Sides not parallel to one another.

TRAVELLING-BAROSCOPE, the same with *Portable Barometer*.

TRAVERSE, a Term in *Gunnery*, signifying to turn a Piece of *Ordnance* which way one pleases upon her *Platform*.

TRAVERSE, a Sea Word used in these Senses; they call the Way of a Ship when she makes Angles in and out, and cannot keep directly to her true Course, a *Traverse*.

Also, the laying and removing a Piece of *Ordnance*, or Great Gun, in order to bring it to bear, or lie level with the Mark, is called *Traversing* the Piece.

TRAVERSE, in *Carpentry*, is a Piece of Iron placed transversely to strengthen and fortify another.

To TRAVERSE, with *Carpenters*, is to plain a Piece of Board against the Grain.

TRAVERSE, in Navigation, is the Variation or Alteration of the Ship's Course, upon the shifting of Winds, &c.

Note, That in Sailing in respect of the Wind, is either *before a Wind*, *by a Wind*, or *Larging*.

If a Ship sail by or against a Wind, there ought to be an Allowance for her Lee-way, and that



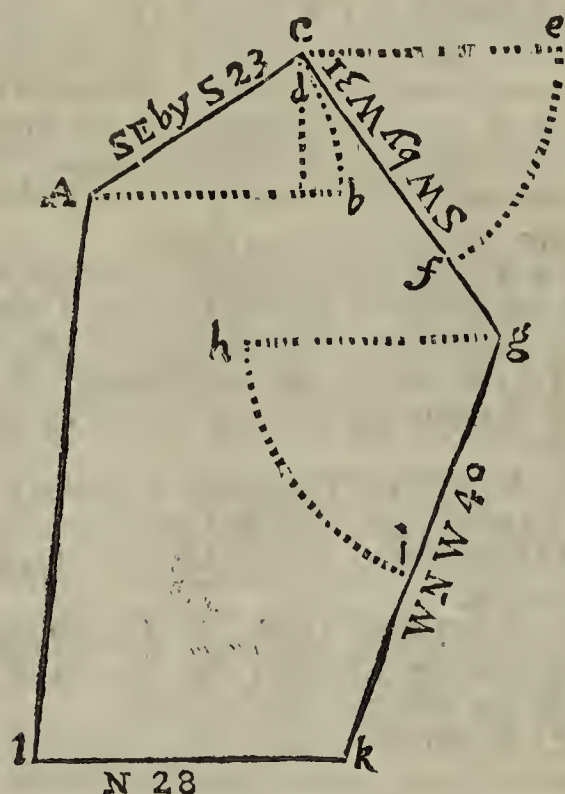
more or less, according to the Growth and Suage  
of the Sea, Mould of the Ship, and Sail she  
bears.

## EXAMPLE,

*Of a Traverse.*

A Ship from Latitude 47 Degrees, 00 Minutes N. Sails S. E. by S. 23 Miles, and then Sails S.W. by W. 31 Miles, and afterwards W. N. W. 40 Miles ; lastly, N. 28 Miles.

I demand the Course and Distance failed from the first Place of Departure, and the Latitude she is now in.



First, Draw the Meridian  $A b$ , with 60 Degrees from the Chords, describe the Arch  $b c$ ; which make equal to 33 Degrees 45 Minutes = 3 Points; draw  $A c$ , and make  $A d$ , or  $A c$  equal to 23 Miles.

Secondly, Draw  $d e$  parallel to  $A b$ ; from  $d$ , with 60 Degrees of the Chords, describe  $e f$ , which make equal to 5 Points, draw  $g f$ , set 31 Miles from  $d$  to  $g$ .

Thirdly, Draw  $g h$ , parallel to  $A b$ ; with 60 Degrees of the Chords describe  $h i$ , which make equal to 6 Points; draw  $g i$ , set 40 Miles from  $g$  to  $k$ .

Fourthly, Draw  $kl$  parallel to  $Ab$ , make  $kl$  equal to 28 Miles; draw  $lA$ , that measured on the *Equal Parts*, gives 50, 4 Miles, and the Angle  $Alk$  measured on the Chords, gives 82 Degrees, or  $7\frac{1}{4}$  Points from the *Meridian*; so that if she had sailed on a straight Line, and single Course from  $A$  to  $l$ , that Course had been W. by N.  $\frac{1}{4}$  Westerly, and the Distance 50, 4 Miles.

*By the Logarithms.*

As the Radius————— 10,00000  
Is to the Dist. of the first Course 23 Mil. 1,36172  
So is the S. Compl. of the Co. S.  $56^{\circ} 15'$  9,91984

To the Diff. Lat. in the first Co. 19, 1 M. 1,28156  
Then, as the Radius—————10,00000

Is to the Distance  $A d$  23 Miles ——— 1,36172  
So is the S.  $33^{\circ} 45'$  =  $\sqrt{d A b}$  the first C. 9,74473

To the Departure in the first Course 12, 8, 1, 10646

Thus proceeding with the several Courses, and Distances given, find the Departures, and Difference of Latitude to them all.

If the Course be between the North and East, then the Difference of Latitude is called Northing, and the Departure Easting; if the Course be in the North-west Quarter, then the Difference of Latitude is called Northing, and Departure Westing. If the Course be between the South, and East, the Difference of Latitude is called Southing, and the Departure Easting, &c.

Now place all the said Differences of Latitude and Departures in a Table, the Northings all under one another, under the Title *Northing*, and the Southings, under the *Southing*; the *Eastings* in the *East* Column, and the *Westings* in the *West* Column.

Then add up all the Northings, as likewise the Southings, and so the Eastings, and also the Westings: Lastly, Take the Sum of the Northings, from that of the Southings, if the Southings make most; or the Sum of the Southings from the Northings, that you may have their Third Difference, which is the Difference of Latitude; as also, the Difference of the Totals of Easting and Westing for the Departure; by which Difference of Latitude and Departure, according to *Case 5.* of Right-angled Triangles, you will find the Direct Course and Distance.

| Courfe.   | Points. | Distance. | North. | South. | East. | West.           |
|-----------|---------|-----------|--------|--------|-------|-----------------|
| S E by S. | 3       | 23        |        | 19,12  | 12,78 |                 |
| S W by W. | 5       | 31        |        | 17,22  |       | 25,78           |
| W N W.    | 6       | 40        | 15,31  |        |       | 36,96           |
| North.    | 0       | 28        | 28,00  |        |       |                 |
| From Sum  |         |           | 43,31  | 36,43  | 12,78 | 62,74           |
| Take      |         |           | 36,34  |        |       | 12,78           |
| Refts.    |         |           | 6,57   |        |       | 49,96 Dep. West |

Departed



Departed }  
 Difference of } Latitude {  $47^{\circ} 00'$  North.  
 Present }  $00^{\circ} 07'$   
 $47^{\circ} 07'$  North.

As the Difference of Latitude 7 Miles—0,845098

Is to the Radius ————— 10,000000

So is the Departure 49,9 ————— 1,698100

To the Tan. of the Course 82,1 ————— 10,853002

And,

As the S. of the Course  $82^{\circ} 1'$  ————— 9,995770

Is to the Departure, 49,9 Miles ————— 1,698100

So is the Radius ————— 10,000000

To the Distance 50,4 Miles ————— 1,702330

### Example 2.

A Ship being bound to the Eastward, and finding the Wind variable, a small Gale, and smooth Water, plies upon these several Courses, with the Distances on each Course, as followeth,

*The Lar-board Tack on Board, Wind from S S W to S, and so to S S E and E.*

|                                  | Miles |
|----------------------------------|-------|
| South-East by East half Easterly | 5     |
| East South-East                  | 4     |
| East by South                    | 7     |
| East half Northerly              | 2     |

*The Star-board Tack on Board, the Wind S E, E S E, E, &c.*

|                     |   |
|---------------------|---|
| South South-West    | 5 |
| South by West       | 6 |
| South               | 4 |
| South South-East    | 7 |
| South-East by South | 3 |

The Direct Course and Distance from the first Place of Departure is required.

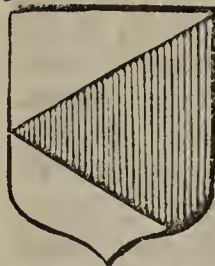
### The Work by the Transverse Table.

| Course.                   | Points.        | Dist. | North. | South.                 | East.                  | West. |
|---------------------------|----------------|-------|--------|------------------------|------------------------|-------|
| SE by E $\frac{1}{2}$ E'y | $5\frac{1}{2}$ | 5     |        | 2 36                   | 4 41                   |       |
| ESE                       | 6              | 4     |        | 1 53                   | 3 70                   |       |
| E by S                    | 7              | 7     |        | 1 37                   | 6 86                   |       |
| E $\frac{1}{2}$ N'y       | $7\frac{1}{2}$ | 3     | 0 29   |                        | 2 98                   |       |
| SSW                       | 2              | 5     |        | 4 62                   |                        | 1 91  |
| S by W                    | 1              | 6     |        | 5 88                   |                        | 1 17  |
| South                     | 0              | 4     |        | 4 00                   |                        | 0 00  |
| SSE                       | 2              | 7     |        | 6 47                   | 2 08                   |       |
| SE by S                   | 3              | 3     |        | 2 49                   | 1 67                   |       |
| Sum                       |                |       | 0 29   | 28 72<br>0 29<br>28 43 | 21 70<br>3 08<br>18 62 |       |

Having set down the several Courses and Distances, then in the *Transverse Table* find the Course on the Head of the Table, if under four Points; but at the bottom, if above four Points; and look the Distance in the Left-hand Column, and in the Square meeting will be the Difference of Latitude and Departure, under the respective Titles.

Thus, above  $3\frac{1}{2}$  Points, and right against 5 m, I find over Title Diff. Lat. 2. 36 m, the *Difference of Latitude*, and over Dep. 4. 14, the *Departure*, in the first Course, which being placed in their proper Columns, according as they are Northing or Southing, &c. Proceed in like manner with all the other Courses or Distances entering and corresponding Differences of Latitude and Departures in their Columns: Then add up the Columns of Diff. of Lat. and Departure, Subtracting the lesser Difference of Latitude from the greater, and the lesser Departure from the greater, and the Remainders are the whole Difference of Latitude and Departure she hath made from the Place of her Departure; so in this Example, she is 28, 43 m to the South of the Place of her Departure; and 18,

62 m East, with which by Case 5th I find her Course SE by S 2 Southerly, and Distance 34 5 m.



TRAVERSE. There is also a Partition of an Escutcheon used in Heraldry of this Figure, which they call *Parted per Pale Traverse*,

*Argent and Gules.*

TRAVERSE, is also a Word much used in Answer to Bills in *Chancery*; or it is that which the Defendant pleadeth or saith in Bar, to avoid the Plaintiff's Bill, either by confessing or avoiding, or by denying and *traversing* the material parts thereof.

To *traverse an Office*, is nothing else but to prove, that an Inquisition made of Lands or Goods by the Escheator, is defective, and untruly made. And to *traverse an Indictment*, is to take Issue upon the chief Matter, and to contradict or deny some Points of it.

TRAVERSE,



**TRAVERSE**, in *Fortification*, is a little *Trench* bordering with two *Parapets*, viz. one on the right Side, and another on the left, which the *Besiegers* make quite thwart the *Moat* of the Place, to pass secure from *Flank-shot*, and to bring the *Miners* to the *Bastions*; it serves as a Cover from the *Enemy*, when they come on their *Flank*. They are of good use to stop an *Enemy's Way*, and to prevent being *enfiladed*. It is also a good Defence in a dry *Ditch*, when the *Parapet* is made on that side next the opposite *Flank*. There is also a *Traverse* in a wet *Ditch*, which is made by throwing into the *Foss* or *Ditch* over against the Place where the *Miner* is to be put to the *Foot* of the *Wall*, *Saucissons*, *Joists*, and other pieces of *Wood*, with *Fascines*, *Stones*, *Earth*, &c. in order to fill up the *Ditch*, and to carry a *Gallery* over it. Also a *Wall* of *Stone* or *Earth*, built a-cross a *Work* which is commanded, in order to cover the *Men*, is called a *Traverse*.

This *Traverse* is usually covered on top with *Hurdles* or *Bavins* laden with *Earth*, for *Security* from the *Fire-works* and differs from a *Coffer* only in this respect, that it is made by the *Besiegers*, and the other by the *Besieged*.

This Word is now often used for any *Retrenchment* or *Line* Fortified with *Fascines*, *Gabions*, *Barrels*, *Bags* of *Earth*, &c.

**TRAVERSE-Board**, is a little round *Board*, hanging up in the *Steerage* of a *Ship*, and bored full of *Holes* upon *Lines* showing the *Points* of the *Compass*; upon it, by moving of a little *Peg* from *Hole* to *Hole*, the *Steer's-man* keeps an *Account* how many *Glasses* (that is, half *Hours*) the *Ship* steers upon any *Point*.

**TRAUMATICKS**, are those things which being taking in *Decoctions* and *Potions*, fetch the *ferous* and *sharp Humours* out of the *Body*, and so attenuate the *Blood*, that it may be conveniently driven to the *wounded*, *broken*, or *bruised Parts*. *Blanchard*.

**TREASON**, is of two sorts, viz. *High* and *Petty Treason*. *High Treason* is defined to be an *Offence* committed against the *Security* of the *King* or *Kingdom*, whether it be by *Imagination*, *Word* or *Deed*; as to compass or imagine the *Death* of the *King*, *Queen*, or *Prince*; or to *Deflower* the *King's Wife*, or his *eldest Daughter* unmarried, or his *eldest Son's Wife*; or *levy War* against the *King* in his *Realm*, adhere to his *Enemies*, counterfeit his *Great Seal*, *Privy Seal*, or *Money*: To kill the *King's Chancellor*, *Treasurer*, *Justices* of either *Bench*, *Justices* in *Eyre*, or *Affize*, or of *Oyer* and *Terminer*, being in their *Place*, doing their *Office*; diminishing or impairing current *Money*, and many others, as may be seen in *divers Statutes* particularly expressed. In case of this *Treason*, a *Man* shall be hang'd, drawn and quartered, and forfeit his *Lands* and *Goods* to the *King*. It is sometimes called *Treason Paramount*, *Petty Treason*. See the Word itself in its proper place.

There is also mention of *Accumulative Treason*, and *Constructive Treason*, in the *Statute 14 Car. II. cap. 29*. And here Note, That *Majori proditione omnes sunt principales*, there are no *Accessaries* in *Treason*, all are *Principals*. And *Voluntas non reputabitur pro facto nisi in causa Proditionis*, for *Petty Treason*.

**TREASURER**, is an *Officer* of great *Trust*. The *Treasurer of England* is a *Lord* by his *Office*, and under his *Charge* and *Government* is all the *King's Money* in the *Exchequer*, and also the *Clerks* of all *Officers* any way employed in collecting the *Imposts*, *Taxes*, *Tributes*, or other *Revenues* belonging to the *Crown*. He hath also, by virtue of his *Office*, the *Nomination* of all *Escheators* yearly throughout *England*; and giveth the *Place* of all *Customs* and *Searchers* in all the *Ports* of the *Kingdom*, with *divers other Matters*.

**TREASURER of the King's Household**, is an *Officer* in the *Court*, who is of the *Privy-Council*, and in the *Absence* of the *Steward of the King's Household*, hath *Power*, with the *Comptroller and Steward of the Marshalsea*, without *Commission*, to hear and determine *Treasons*, *Misprisions* of *Treason*, *Murder*, *Homicide*, and *Bloodshed*, committed within the *King's Palace*.

**TREASURE-TROVE**, is when any *Money*, *Gold*, *Silver*, *Plate*, or *Bullion* is found in any *Place*, and none knows to whom it belongs; then the *Property* thereof belongs to the *King*, but the *Civil Law* gives it to the *Finder*, according to the *Law of Nature*. The *Punishment* for concealing *Treasure found*, is *Imprisonment* and *Fine*. But if any *Mine* or *Metal* be found in any *Ground*, that always pertains to the *Lord* of the *Soil*, except it be a *Mine* of *Gold* or *Silver*, which used to be always to the *King*, in whose *Ground* soever it be found: But by a late *Act of Parliament*, the *King* hath only the *Præ-emption*.

**TREBLE**, is the last or highest of the four *Parts* in *Musical Proportion*.

**TREENELS**, in a *Ship*, are long *Pins* or *Nails* of *Wood*, whence they are called *Tree-nells*, or *Tree-nails*, made out of the *Heart* of *Oak*, to fasten the *Planks* to the *Timber*; and these have always *Oakum* driven into them, to prevent any *Leak*.

**TREES** and *Shrubs*, of our *Native Growth* in *England*, are thus distinguished by our most *Judicious Botanist Mr. John Ray*.

I. Such as have their *Flower* disjoined and remote from the *Fruit*; and these are,

1. *Nuciferous ones*, or such as bear *Nuts*, as the *Walnut Tree*, the *Hazel Nut-tree*, the *Beach*, the *Chestnut*, and the *common Oak*.

2. *Coniferous ones*, or such as bear a *squamous* or *scaly Fruit*, of a kind of *Conical Figure*, and of a *woody* or *hard Substance*, in which are many *Seeds*, which when they are *ripe*, the *Cone* opens or gapes in all its several *Cells* and *Partitions*, and so they drop out. Of this Kind are the *Scotch Firs*, *Male* and *Female*; the *Pine*, which in our *Gardens* is called the *Scotch Fir*; the *common Alder Tree*, and *Birch Tree*,

3. *Bacciferous ones*, or such as bear *Berries*; as *Juniper* and the *Yew Tree*.

4. *Lanigerous ones*, or such as bear a *woolly downy Substance*; as the *black*, *white*, and *trembling Poplar*, *Willows*, and *Others* of all kinds.

5. Such



5. Such as bear their Seeds (having an imperfect Flower) in leafy Membranes or Cases, as the *Horn-beam* or *Hard-beam*, called in some places the *Horn-beech*.

II. Such as have their Fruits and Flowers contiguous; and these are either with the Flower placed on the Top of the Fruit, or else have it adhering to the Base or Bottom of the Fruit.

1. Trees and Shrubs with the Flower placed on the Top or Upper-part of the Fruit: Of these, some are *Pomiferous*, as Apples and Pears; and some *Bacciferous*, as the Sorb or Service Tree; the White or Haw-Thorn, the wild Rose, Sweet-brier, Currants, the great Bilbery Bush, Honey Suckle, Ivy, &c.

2. Trees whose Flower adheres to the Base or Bottom of the Fruit, are either such as have their Fruit moist and soft when ripe, as,

1. *Pruniferous ones*, whose Fruit is pretty large and soft, with a Stone in the middle; as the black Thorn or Slow-tree, the black and white Bullace-tree, the common wild Cherry-tree, the black Cherry, &c.

2. *Bacciferous ones*; as the Strawberry Tree, in the West of Ireland, Mistletoe, Water-elder, the Dwarf large Lawrel, the Viburnum or Way-faring Tree, the Dog-berry Tree, the Sea black Thorn, the Berry-bearing Elder, the Privet Barberry, common Elder, the Holly, the Buck-thorn, the Berry-bearing Heath, the Bramble and the Spindle-tree, or Prick-wood.

Such as have their Fruit dry when 'tis ripe; as the Bladder Nut-tree, the Box-tree, the common Elm and Ash, the Maple, the *Gaule* or *Sweet-willow*, common Heath, Broom, Diers-weed, Furze, or Gorse, the Lime-tree, &c.



TREFFLE, in *Heraldry*, as a *Cross Treffle*, is a Cross whose Arms end in three Semi-circles, each representing the Three-leaved Grass, or Trefoil. This is by some called *St. Lazarus Cross*. See the Figure.

TRE-FOIL, *Trifolium*, *Treffle*, F. [of *τρίφυλλον*, Gr.] the Herb Three-leaved Grass.



TREFOILS, in *Heraldry*, called in *French Treffles*, are frequently born in Coat Armour, representing Three-leaved Grass, and are accounted next to the *Fleur-de-Lis*, or Lilies. See the Figure.

TREMOR, is a voluntary Motion depraved, by which the Member is sometimes raised up, and sometimes depressed through the mutual Contraction between the Faculty and the Part affected.

TRENCHES, in *Fortification*, are certain Moats or Ditches, which the Besiegers cut to approach

more securely to the Place attacked, and are of several sorts, according to the different Nature of the Soil; for if the adjacent Territory be Rocky, the Trench is only an Elevation of *Bavins*, *Gabions*, *Wool-packs*, or Shouldrings of Earth cast up round about the Place: But where the Ground may be easily opened, the Trench is dug therein, and bordered with a Parapet on the Side of the Besieged. The Breadth of it ought to be from 8 to 10 Foot, and the Depth from 6 to 7.

These *Trenches* are to be carried on with winding Lines, in some manner parallel to the Works of the Fortrefs, so as not to be in view of the Enemy, nor to expose its Length to their Shot, which they call *Enfiladed*; for then it will be in danger of being *Enfiladed*, or scoured by the Enemies Cannon: And this carrying of the Trenches obliquely, they call, carrying the Trenches by *Coudees* or *Traverses*.

They call it *Opening the Trenches*, when the Besiegers begin to Work upon the Line of Approaches, and this is usually done in the Night, and sometimes within Musket-shot, and sometimes within half or whole Cannon-shot of the Place, if there be no rising Ground about it, the Garrison strong, and their Cannon well served. The Workmen that open the Trenches, are always supported by Bodies of Men against the Sallies of the Besieged; and sometimes those Bodies lie between them and the Place, as also on their right and left. The Pioneers sometimes Work on their Knees, and the Men that are to support them, lie flat on their Faces, in order to avoid the Enemies shot: And the Pioneers are also usually covered with *Mantelets* or *Saucissons*. They also say, *Mount the Trenches*; that is, go upon Duty in them: And to *Relieve the Trenches*, is to Relieve such as have been upon Duty there. To *carry on the Trenches*, is to advance them towards any Place.

To *TRENCH the Ballast*, a Sea Phrase, is to divide the Ballast in a Ship's Hold into several Trenches.

TREPANNING, in *Chirurgery*, the Operation of using an Instrument in helping Contusions, Fractures, &c. in the Skull.

TREPANUM, the same with *Modiolus*; which see.

TREPIDATION, in *Physick*, a Trembling or Tremor of the Members and Nerves of the Body.

TREPIDATION, with the ancient *Astronomers*, a Libration of the eighth Sphere; or a Motion attributed by the Ptolemaick System to the Firmament, in order to account for certain almost insensible Changes and Motions that they observed in the Axis of the World; by means of which the Latitudes of the fixed Stars came to be gradually changed, and the Ecliptick seemed to approach reciprocally first towards one Pole, then towards the other.

TRESPASS, signifies any Transgression of the Law under Treason, Felony, or Misdemeanor of either; for a Lord of the Parliament to depart from thence without the King's Licence, is neither Treason nor Felony, but *Trespafs*.

But this Word is most commonly used for that Wrong or Damage which is done either to the King in his Forest, or by one private Man to another; and according to this Signification, it is of two sorts; *Trespafs General*, otherwise called *Trespafs vi & armis*; and *Trespafs Special*, otherwise called



called *Trespass upon the Case*: and this seemeth to be without Force, howbeit they are sometimes confounded. How to distinguish the Forms of these Writs or Actions, see F. N. B. Fol. 86, 87. In an Action of *Trespass*, the Plaintiff always Sues for Damages, or the Value of the Hurt done him by the Defendant. There is also *Trespass local*, and *Trespass transitory*. *Trespass local* is that which is so annexed to the Place certain, that if the Defendant join issue upon a Place, and traverse the Place only by saying *absque hoc*, That he did the *Trespass* in the Place mentioned in the Declaration, and aver it, it is enough to defeat the Action. *Trespass Transitory*, is that which cannot be defeated by the Defendant's Traverse of the Peace, because the Place is not material: But the Action of *Trespass quare clausum fregit*, ought to be *local*.

TRESSEL-TREES, in a Ship, are those Timbers of the Cross-tree that stand along Ships, or Fore and Aft at the Tops of the Masts. See *Cross-trees*.



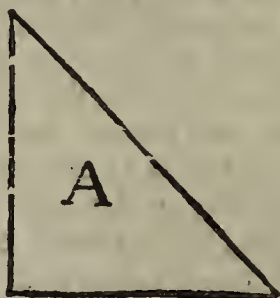
TRESSURE, in Heraldry, is the Diminutive of an Orle, and is usually accounted to be only one half of it, and is commonly born Flory and Counterflory, and it is also often double, and sometimes treble.

TRIA Prima, are Salt, Sulphur, and Mercury, the three Hypostatical Principles of the Chymists, out of which they pretend that all mixed Bodies are compounded, and into which they are ultimately resolvable by Fire; but the latter is false, and the first impossible to be proved.

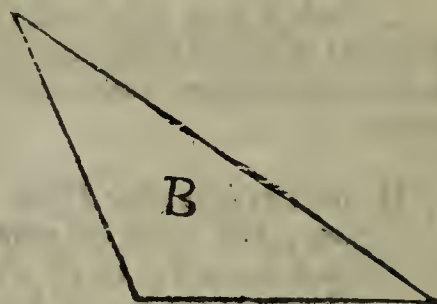
TRIAL, in Law, is used for the Examination of all Causes, Civil and Criminal, according to the Laws of the Realm, before a proper Judge: Of which there are divers kinds, as Matters of Fact shall be tried by the Jurors; Matters of Law, by the Justices; Matters of Record, by the Record itself. A Lord of Parliament, upon an Indictment of Treason or Felony, shall be Tried without any Oath by his Peers, upon their Honours and Allegiance; but in Appeal at the Suit of any Subject, they shall be Tried *per bonos & legales homines*. If ancient Demesne be pleaded of a Manor, and denied, this shall be Tried by the Record of *Doomsday*. Bastardy, *Excommengement*, Lawfulness of Marriage, and other Ecclesiastical Matters shall be Tried by the Bishop's Certificate.

TRIANGLE, is a Figure having three Angles and three Sides only, and is either *Spherical* (which see) or *Plane*, whose Sides are Right Lines. Every *Plane Triangle* may be consider'd with relation either to its Angles, or its Sides. As to its Angles, 'tis either,

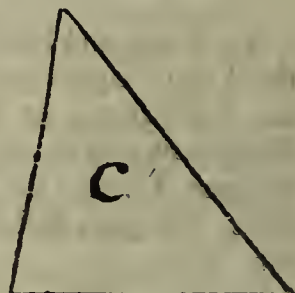
1. *Right Angled Triangle*, is that which hath one *Right Angle*, as A.



2. *Obtuse Angled Triangle*, is such as hath one *Obtuse Angle*, as B.



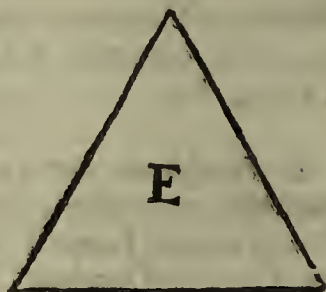
3. *Acute Angled Triangle*, is that which hath all its Angles *Acute*, as C.



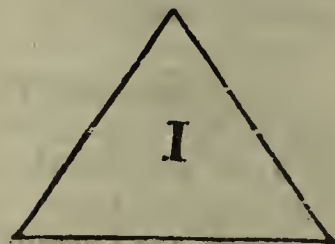
N. B. Any Triangle that is not Right Angled is called *Oblique Angled*, or *Amblygonial*.

A Triangle, as to its Sides, is either,

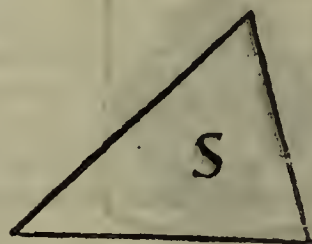
1. *Equilateral Triangle*, is that which hath all its Sides equal to one another, as E.



2. *Isoceles*, or an *Equilegg'd Triangle*, is that which hath only two Sides equal, as I.



3. *Scalenous Triangle*, is that which has no two Sides equal, as S.



To find the *Area* of all Triangles, see *Area*.

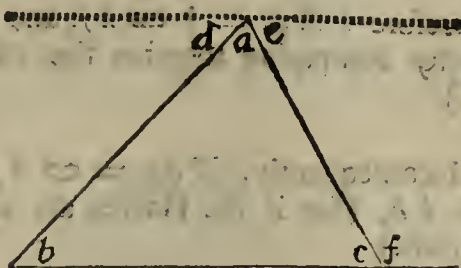
Of the Properties of Plane Triangles.

#### PROPOSITION I.

In every Triangle, the Sum of all the three Angles is equal to two Right ones; and the external Angle made by any Side produced, is equal to the Sum of the internal and its opposite.

$$\begin{array}{l} \text{I say, 1. } a + b + c = 2 \text{ } \checkmark \\ \quad \quad \quad 2. f = b + a. \quad \quad \quad \} \end{array}$$





Draw the prick'd Line through the Vertex parallel to the Base: Then will the Angles  $d$  and  $e$  be severally equal to the alternate ones  $b$  and  $c$ . (29 *l.* 1. *Eucl.*) But  $d + a + e = \angle$  (by Cor. 2. 13 *l.* 1. *Eucl.*) Wherefore  $b + a + c = 2 \angle$ . *Q. E. D.*

## COROLLARY I.

Hence no  $\Delta$  can have 2 obtuse or 2  $\angle$ .

## COROL. II.

In a Right-angled  $\Delta$ , the 2 oblique Angles must make a Right one between them.

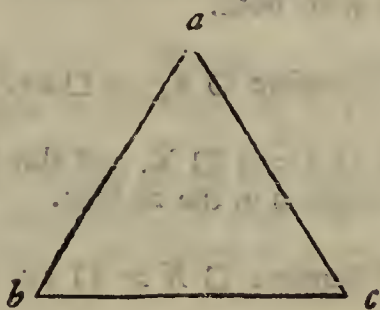
## COROL. III.

If 2 Angles in one  $\Delta$  be  $=$  to 2 in another, the remaining Angles must also be equal.

## PROP. II.

In the same Triangle, equal Sides subtend, and are subtended by equal Angles.

I say, if  $a = b$ , then  $ac = cb$ .

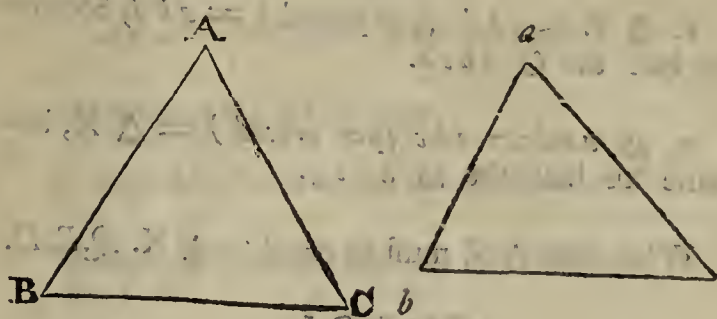


Because the Angles  $a$  and  $b$  are equal, the Lines  $ac$  and  $cb$  must be equally inclined to the Base  $ab$ ; and consequently, be so at the Point  $c$  where they meet; and therefore  $c$  must be equidistant from  $a$  and  $b$ ; for if  $c$  be nearer to, or farther from  $b$  than  $a$ , it must be because the Angle  $a$  is lesser or greater than  $b$ , which is contrary to the Supposition.

And on the other hand, if the Sides are equal, the Angles must; for being equal, they must needs be equally inclined to the Base  $ab$ , in the Point  $c$ , where they meet.

## PROP. III.

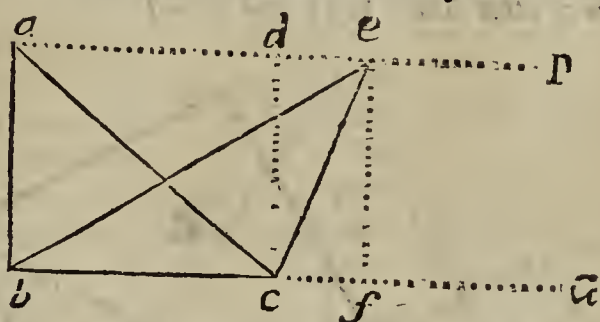
In two Triangles  $ABC$ , and  $abc$ , if all the three Sides, or two Sides and one Angle, or two Angles and one Side be respectively equal one to another, the whole Triangles are equal.



For being laid one on another, they will concur.

## PROP. IV.

Triangles on the same Base, and having the same Height, (that is, being between the same parallel Lines) are equal.



I say the Triangles  $abc$ , and  $ebc$ , having the same Base  $bc$ , and between the same parallel Lines  $aP$  and  $bC$ , are equal.

Draw  $dc$  and  $ef$  parallel to  $ab$ .

1. The Triangles  $dce$  and  $ecf$  are equal, because each equal to half the Parallelogram  $df$ .

2. The Triangles  $abe$  and  $ebf$  are also equal, being each equal to half the Parallelogram  $af$ .

3. But  $\Delta abc + \Delta cef = \text{half the } \square af$ .

4. And  $\Delta ebc + \Delta cef = \text{half the } \square af$ .

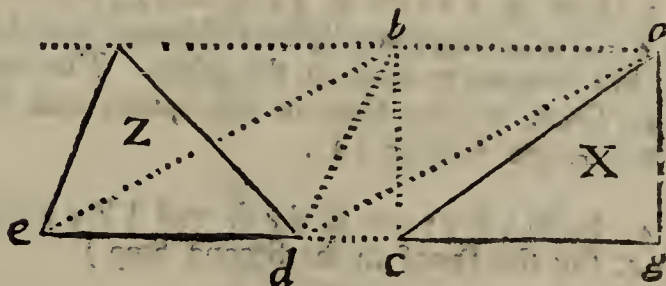
Therefore, if the  $\Delta cef$  be taken away from both Sides, the  $\Delta ebc$  must remain  $=$  to the Triangles  $abc$ . *Q. E. D.*

## PROP. V.

Triangles on equal Bases, and between the same Parallel Lines, are equal.

I say  $\Delta Z = \Delta X$ .

Draw  $bc$  parallel to  $ag$  join'd  $da$ ,  $db$ , and  $be$ .





1.  $\Delta Z = ebd$ . (per preced.)  $= abd$ , because 'tis half the  $\square abed$ .

2.  $\Delta abd = abc$  (per preced.)  $= \Delta X$ , because 'tis half the  $\square abcg$ .

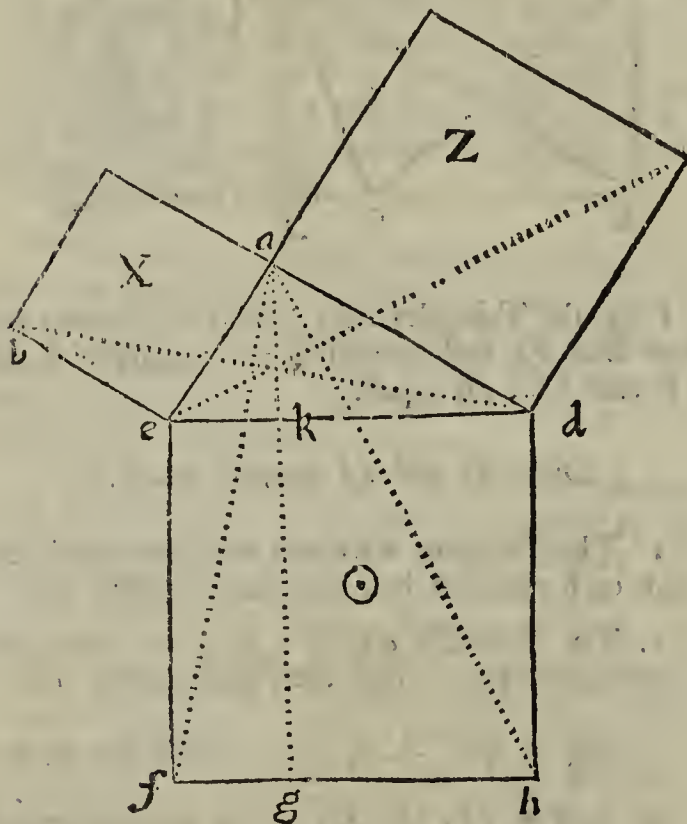
Wherefore  $\Delta Z$  must be equal to  $\Delta X$ . Q.E.D.

COROL.

Hence follows, that if two Lines have between them equal *Triangles* on the same or equal Bases, these Lines must be parallel to each other.

PROP. VI.

I say the Square of the Hypotenuse (ed) of a Rect-angled  $\Delta$  (ead) is equal to both the Squares of the 2 other Sides (ae) and (ad.)



That is,

$$\square Oq; = Z = q; + X q;$$

1.  $\square Oq; = \square kf + \square kb$ .

2.  $\frac{1}{2} \square kf = \Delta fae$ , and  $\frac{1}{2} \square kb = \Delta adb$ ; because  $\square$ s on the same Bases, are double to  $\Delta$ s that have the same perpendicular Height, or are between the same parallel Lines.

3. But  $\Delta fae = \Delta bed$ , and  $\Delta bda = \Delta ecd$ , as having severally two Sides and one Angle in one equal to those in the other. The two equal Sides, are the Sides of the Square, and the obtuse Angle  $bed = edc$ .

4. Now  $\frac{1}{2} X q; = \Delta bed$ , and  $\frac{1}{2} Z q; = \Delta dce$ , (by the Proof in the Second Step.)

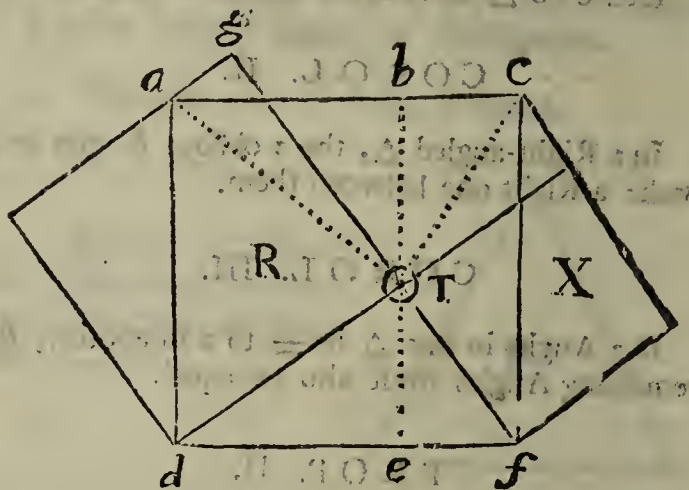
5. Therefore  $\frac{1}{2} X q; = \frac{1}{2} \square kf$ , and  $\frac{1}{2} Z q; = \frac{1}{2} \square kb$  (by comparing together the 2d, 3d and 4th Steps.)

6. And consequently,  $X q; = \square kf$ , and  $Z q; = \square kb$ , (for if the Halves are equal, the Wholes must.)

Wherefore  $X q; + Z q; = O q;$  (by the first Step.) Q. E. D.

The Second Way.

I say the Square of  $df =$  Sum of the Squares of  $do$  and  $of$ .



1.  $\square df = \square ae + \square ec$ .

2. The  $\Delta aod = \frac{1}{2} \square dg$ , and also  $=$  to  $\frac{1}{2} \square ae$ , because on the same Base, and between the same Parallels with both.

Wherefore  $\square dg = \square ae$ ,

3. The  $\Delta cof = \frac{1}{2} \square X$ , and also to  $\frac{1}{2} \square ec$  for the Reason given in the 2d Step.

Wherefore  $\square X = \square ec$ .

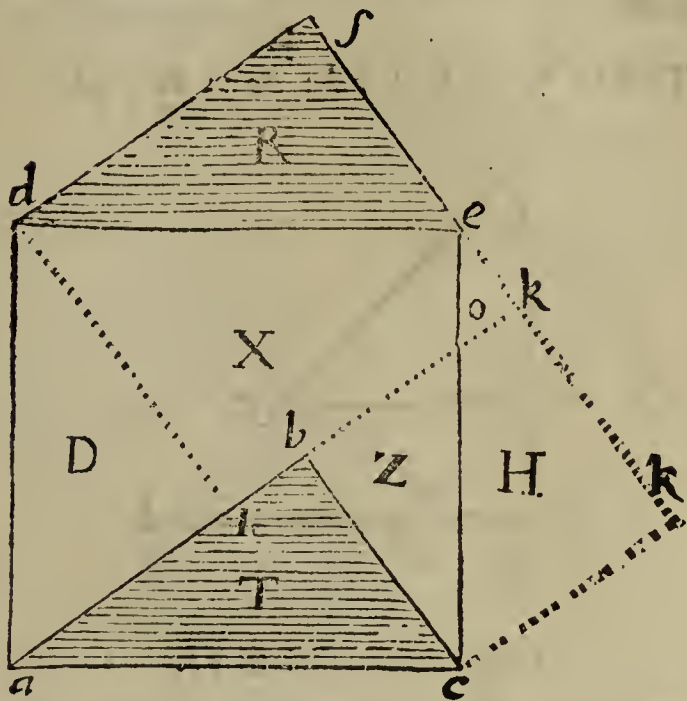
4. And consequently,  $\square dg + \square X$  is equal to  $\square df$ , (by Step 1.) Q. E. D.

The



*The Third Way.*

I say,  $acq; = abq; + bcq;$



Make  $bk =$  to  $ab$ , and compleat all the Squares.

Then will,

$$\begin{aligned} \square ac &= D + X + Z + T. \\ \square ab &= X + R + O. \\ \square bc &= Z + H. \end{aligned}$$

Wherefore taking away what is common, remains  $D + T = R + H + O$ . But then,

$R = T$ , bec.  $ac = de$ ,  $df = ab$ , and  $\angle f = b$ .

Remains to be proved, that

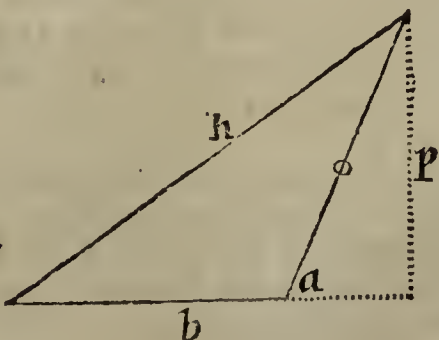
$D = H + O$ . Which it is, because  $D = R$ , (as having  $z =$  Sides and one  $\angle$ ) and  $R$  was proved  $= T$ , and  $T = O + H$ , because  $ac = ce$ , the Angle at  $b = k$ , and the Angle  $abc = eck$ , (because each with  $bce$  makes a  $\angle$ .)

Wherefore, the Square of  $ac = abq; + bcq;$   
Q. E. D.

PROP. VII.

In an Obtuse-angled Triangle, the Square of the Side subtending the Obtuse Angle, exceeds the Sum of the Squares of the other two Sides by the double Rectangle ( $2ba$ ) under the Base, and the Part added to it.

Let fall the Perpendicular  $p$ , and produce  $b$ , 'till it meet with it.



*Demonstration.*

$$1. hh = bb + 2ba = aa + pp.$$

$$2. \text{And } oo = pp + aa.$$

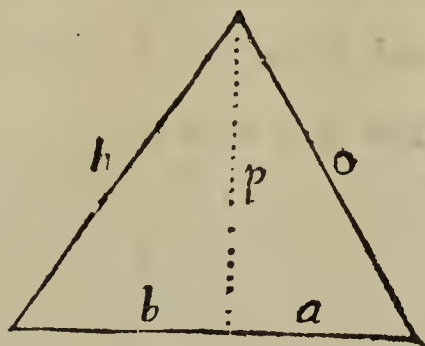
$$3. \text{But } bb + oo = bb + aa + pp.$$

Wherefore  $hh$  exceeds the last Step by  $2ba$ .  
Q. E. D.

PROP. VIII.

In an Acute-angled Triangle, the Square of the Side ( $h$ ) subtending an Acute, is less than the Sum of the Squares of the other two Sides, by double the Rectangle under the whole Base ( $b + a$ ) and the Segment of the Base ( $a$ ) which is next to the Acute-Angle.

Let fall the Perpendicular  $p$ .



*Demonstration.*

$$1. hh = bb + pp.$$

$$2. oo = pp + aa.$$

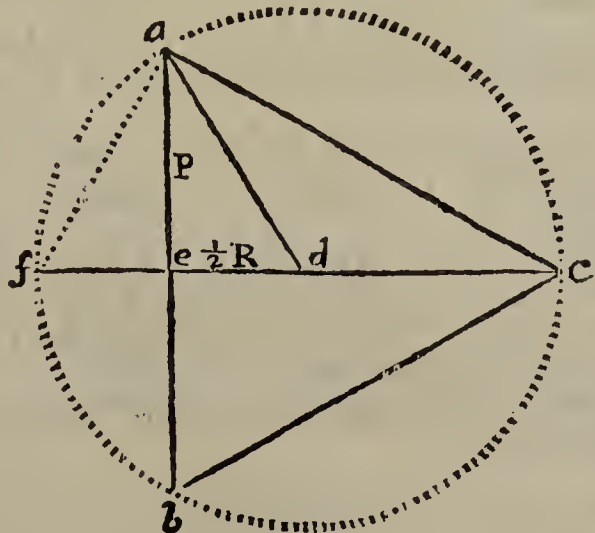
$$3. Q. \overline{b+a} = bb + 2ba + aa.$$

4.  $bb + pp + 2aa + 2ab$ , is the Sum of the Squares of the Legs.

Wherefore  $hh$  is less than that by  $2aa + 2ab$ , which is plainly equal to the Double Rectangle under the whole Base, and the Part  $a$ .

PROP. IX.

The Side  $ab$  of an Equilateral Triangle  $abc$ , inscribed in a Circle, is in Power triple of the Radius; or its Square is equal to thrice the Square of the Radius  $a d$ .





Let the Radius be called  $R$ , and consequently its Square  $RR$ .

I say, then  $de = \frac{1}{2} R$ , for the two Triangles  $fea$ , and  $ead$ , are equal, as having two Angles and one Side equal, in both. Wherefore, the Square of  $ed = \frac{1}{4} RR$ ; which being subtracted from  $RR$ , leaves  $PP = \frac{3}{4} RR$ . Wherefore  $P = \sqrt{\frac{3}{4} RR}$ ; and consequently its double  $ab = 2\sqrt{\frac{3}{4} RR}$ ; i. e. to the  $\sqrt{\frac{12}{4} RR}$ , or to  $\sqrt{3 RR}$ . Wherefore  $3 RR = \square$  of  $ab$ ; or  $abp = 3 RR$ . Q. E. D.

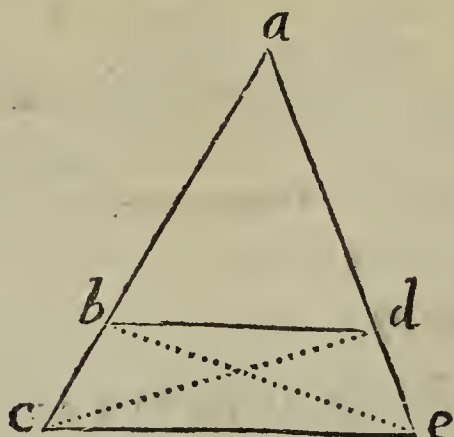
N. B. Herein is founded Euclid's way of generating a Tetrahedrum, and inscribing it in a given Sphere. See Prop. 13 è 13.

PROP. X.

The Sides of a Triangle are cut proportionably by a Line drawn parallel to the Base.

That is, it makes,  $ab : bc :: ad : de$ .

Draw the Lines  $be$  and  $cd$ .



Demonstration.

1. The Triangles  $bdc$ , and  $bde$ , are equal, because on the same Base, and between the same Parallels. Therefore the Triangle  $abd$ , will have the same Proportion to them both, that is,  $abd : bdc :: abd : bde$ . But the Triangle  $abd$ , having the same Height with the two equal Triangles  $bdc$ , and  $bde$ , will be to them as its two Sides  $ab$  and  $ad$ , are to their Bases  $bc$  and  $de$ .

Therefore  $ab : bc :: ad : e$ .

Which Proportionals may be considered and varied according to the several Species of Proportion.

As by Inversion,  $cb : ab :: dc : e$ : the Parts of the Legs below the Parallel, are proportional to those above it.

Also, Alternately,  $ab : ad :: eb : de$ . The Part of one Leg above the Parallel, is to the Part of the other Leg above the Parallel, as the Parts below are to one another.

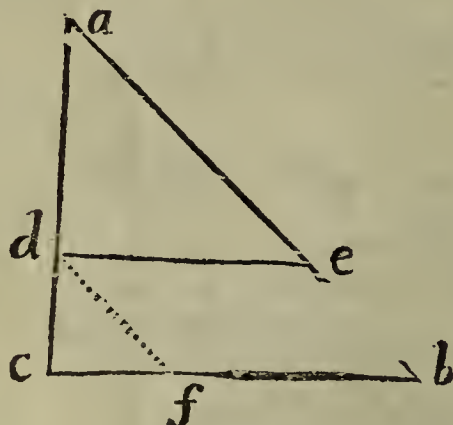
The same Thing may be done by Composition and Division, &c.

PROP.

PROP. XI.

In a Triangle, a Parallel to the Base, is to the Base, as the Parts above the Parallel are to the whole Legs.

That is,  $de : cb :: ad : ae :: ae : ab$ .



Draw  $df$  parallel to  $eb$ .

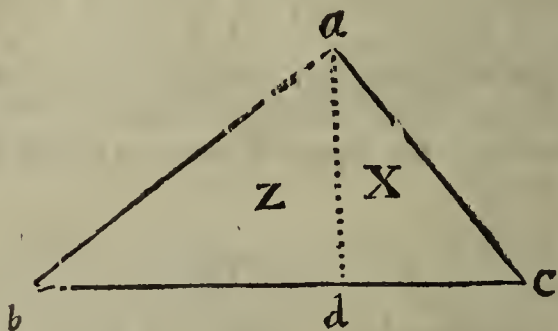
Then will  $fb = de$ : Therefore 'twill be  $bf : fc :: da : dc$ : And by

Inversion,  $fc : bf :: dc : da$ . And then by Composition,  $fc + bf$  (i. e.  $bc$ ) :  $bf$  (i. e.  $de$ ) ::  $dc + da$  (i. e.  $ac$ ) :  $da$ ;

or as  $cb : de :: ac : da$ . Which, Inverted, gives  $de : cb :: ad : ac$ . Q. E. D.

PROP. XII.

In a Right-angled Triangle ( $abc$ ) a Line ( $ad$ ) drawn from the Right-angle at the Top, perpendicular to the Hypotenuse ( $bc$ ) divides the Triangle ( $abc$ ) into two other Right-angled Triangles, which are similar to the first Triangle, and to one another.



1. For all three Triangles have one Right-angle. And the Triangles  $abc$ , and  $abd$ , have the Angle  $b$  (common to both) and consequently the third Angle  $bad$ , must be equal to  $c$ . Wherefore these two Triangles are similar.

2. The Case is the same, as to the Triangles  $abc$  and  $adc$ : But the Triangles  $abd$  and  $adc$ , being similar to the great one  $abc$ , must be also similar to one another. Q. E. D.

From the Similarity of which three Triangles, it will follow, that the Sides about the equal Angles are proportional (by 4 è 6. Eucl.) and thence arises the Proof of the next Famous Proposition, by this means proved a fourth way.

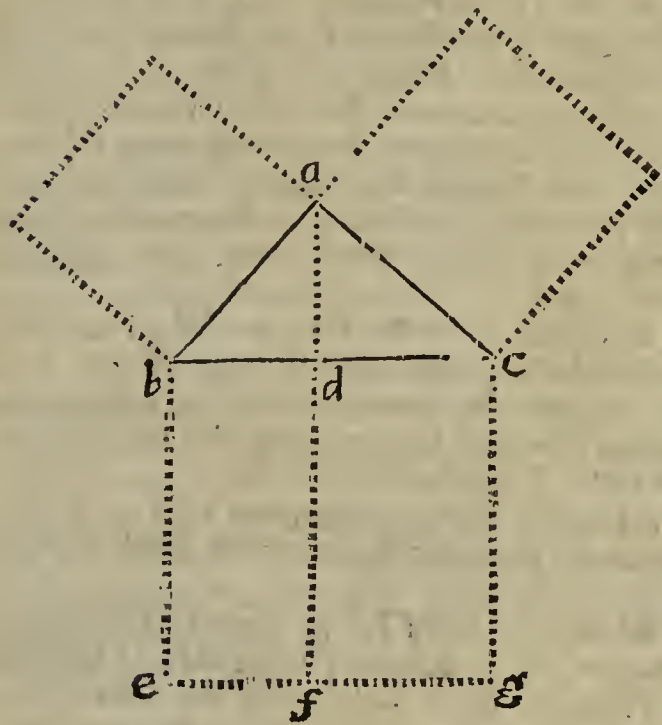
PROP.



## P R O P. XIII.

In every Right-angled Triangle, the Square of the Hypotenuse is equal to the Sum of the Squares of the other two Sides.

I say,  $\square bc = \square ba + \square ac$ .



Demonstration.

1. For the Square  $bc$  is made up of the two Rectangles  $bf$  and  $dg$ .

But  $\square bf = \square ba$ , for  $cb : ba :: ba : bd$ . That is,  $\square ba = cb \times bd = \square bf$ .

And  $\square dg = \square ac$ , for  $bc : ac :: ac : cd$ . That is,  $\square ac = bc \times cd = \square dg$ .

Wherefore  $\square bc (= \square bf + \square dg) = \square ba + \square ac$ . Q. E. D.

## C O R O L L A R Y.

Hence 'tis plain, that any Figure made on the Hypotenuse of any Right-angled Triangle, shall be equal to two other similar Figures made on the Sides. Because all such Figures are to one another, as the Squares of their Homologous Sides.

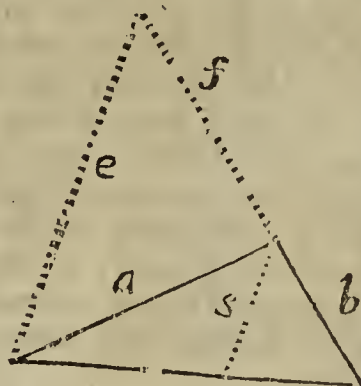
You have above three other ways of demonstrating this admirable Proposition, without the Doctrine of Proportion being first learnt.

## P R O P. XIV.

If any Angle of a Triangle be bisected, the Bisecting Line will divide the opposite Side in the same Proportion as the Legs of the Angle are to one another.

Let the Sides of the Triangle be  $a, b$ , and  $c + d$ , and the Bisecting Line  $s$ .

I say,  $a : b :: c : d$ .



Produce the Leg  $b$ , 'till  $f = a$  the other Leg of the Angle, and draw the Line  $e$ . Then will the Triangle  $e f a$  be an *Isoceles*; and consequently the Angles at the Base  $e$ , will be equal: And therefore each will be equal to half the bisected Angle (because that is external and equal to them both:) Therefore in the first Triangle, the Bisecting Line  $s$  is parallel to the Base  $e$ ; and consequently,  $f : b :: c : d$ .

That is,  $a : b :: c : d$ ? Q. E. D.

TRIANGULAR Compasses, are such as have three Legs or Feet to take off any Triangle at once; they are used in Maps, Globes, &c.

TRIANGULAR Quadrant, is a Sector, with a loose Piece to make it an *Equilateral Triangle*; the Calendar is graduated on it with the Sun's Place, Declination, and many other useful Lines, and by the help of a String and a Plummets, and the Divisions graduated on the loose Piece, it may be made to serve for a Quadrant.

TRIANGULARE Officulum, the Triangular little Bone, is that which is placed betwixt the Lambdoidal Suture of the Skull, and the *Sagittalis*. Blanchard.

TRIANGULARIS, a Muscle of the *Thorax*, which with its Partner, lies on each Side the *Cartilago Ensiformis*, within the Cavity of the *Thorax*, under the *Sternum*; sometimes this appears to be three, at other times four distinct Muscles on each Side. It arises from the inferior Part of the *Os Pectoris*, whence its upper Part ascends, and lower descends to its Implantations at the Bony Endings of the fourth, fifth, sixth, and sometimes seventh and eighth Ribs, near their Conjunction with their Cartilages. Its reputed Use by most (if not all) Anatomists, is to contract the Breast.

TRIANGULUS Septentrionalis, or *Deltoton*, the Triangle, a Northern Constellation consisting of 6 Stars.

TRIAS Harmonica, in Musick, a Compound of three Radical Sounds heard all together; two of which are a Fifth and a Third above the other, which is the Fundamental.

TRIBRACHYS]







## DEFINITIONS.

1. The Line  $DT$  in a Circle, is called the Diameter; one half of which,  $CT$ , as also  $CO$ , and  $CF$ , is called the Radius; and by some the whole Sine, because all other Sines are taken out of it.

2. Any Right-line, as  $OA$ , joining the two Extremities of an Ark, is called the Chord, or Subtense, either of the Ark  $OTA$ , or of its Complement to a whole Circle  $ODA$ .

3. The Line  $OR$ , which is perpendicular to the Radius  $CT$ , or which is just half the Chord  $OA$ , is called the Right-sine, or most usually the Sine of the Ark  $OT$ ; or of the Ark  $OD$ ; so that a Right-sine is half the Chord of double the Ark.

4. The Difference of any Ark from a Quadrant, be it more less, is called its Complement. Thus  $OF$  is the Complement of the Ark  $OT$ , being what it wants of being a Quadrant; and  $OF$  is also the Excess by which the Ark  $OD$  exceeds a Quadrant; the Line  $ro$  is the Right Sine of the Complement, and therefore 'tis called the Co-sine or Sine-complement of the Ark  $OT$ ; as  $OR$  is the Co-sine of the Ark  $FO$ .

5. A Line, as  $TS$ , touching the Circle in the Point  $T$ , and perpendicular to the Radius  $CT$ , is called a Tangent: And if a Right-line be drawn through  $O$  from the Centre of the Circle  $C$ , meeting with the Tangent in  $S$ , that Line  $SC$  is called a Secant, and they both limit one another, so as to be the Tangent and Secant of the Ark  $OT$ :  $FN$  is the Co-tangent; and  $CN$  the Co-secant of the same Ark; but they are the Tangent and Secant of the Complemental Ark  $OF$ .

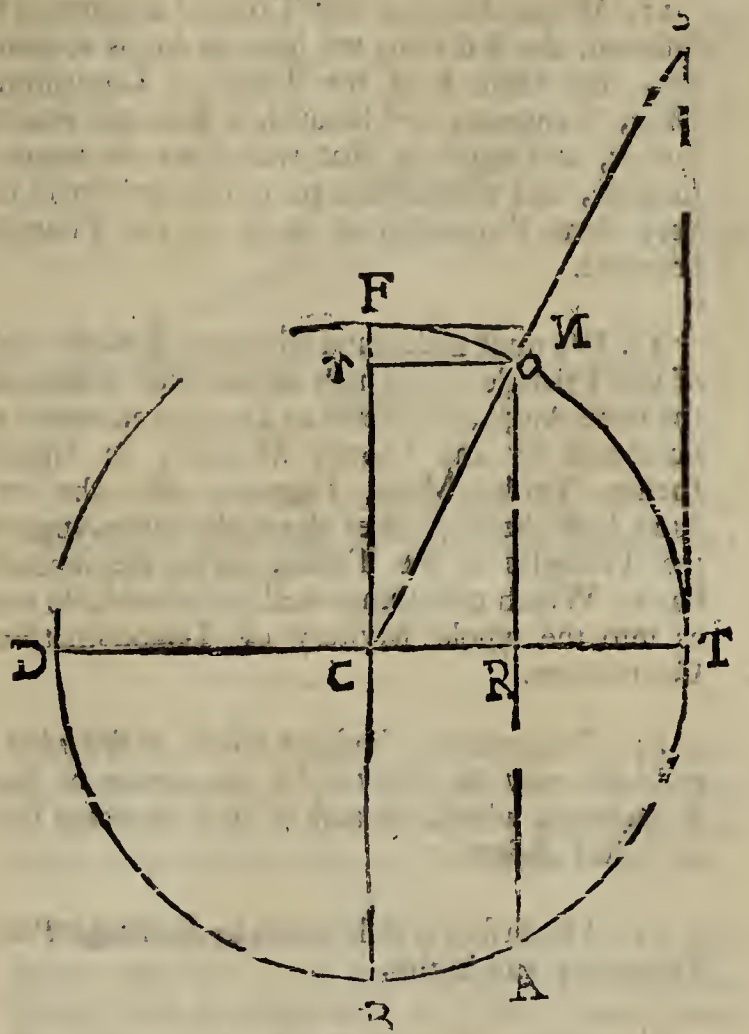
6. The Line  $RT$  intercepted between the Right-sine and the Tangent, is called the Versed-sine, and by some *Sagitta*.

7. Whatever Number of Degrees an Ark wants of a Semi-circle, is called its Supplement.

8. The Line  $CR$ , which is the Part of the Radius  $CT$  lying between the Centre and the Right-sine, is always equal to, and may be taken for the Co-sine  $ro$ ; and  $Cr$  is equal to the Right-sine  $OR$ .

9. If any Ark be less than a Quadrant, as  $TO$ , the Difference between the Radius and the Co-sine, is the Versed-sine  $RT$ ; but if it exceed a Quadrant, as the Ark  $DFO$  doth, then the Sum of the Radius and Co-sine, is the Versed-sine: Thus  $DC + CR = DR$  the Versed-sine of the Ark  $DFO$ .

10. The Radius with the Sine and Co-sine of any Ark (as  $TO$ ) do make a Right-angled Triangle, as  $OCR$ , which is similar to the Triangle  $CST$ , made by the Radius, the Tangent, and the Secant; make another Triangle similar to the two former.



Hence 'tis plain,

1. That as the Co-sine is to the Sine :: So is the Radius to the Tangent. That is,  $CR : RO :: CT : TS$ .

2. As Radius is to the Sine :: So is the Secant to the Tangent. That is,  $CO : OR :: CS : ST$ .

3. As the Sine is to the Radius :: So is the Radius to the Co-secant. That is,  $OR : OC :: FC : CN$ .

4. As the Tangent is to the Radius :: So is Radius to the Co-tangent; As  $ST : TC :: FN$ .

Therefore the Rectangle between the Tangent and Co-tangent of any Ark is equal to the Square of the Radius.

11. Every Triangle has six Parts, of which three are Sides, and three Angles; and of these if we have three given, we can find the rest (except in the Case where the three Angles only of a plain Triangle are given.)

For from thence the Sides cannot be found, because two Triangles may be equiangular, and yet have the Sides by no means of the same length. We can find the rest, I say, if supposing the Radius divided into any Number of equal Parts, we can but discover how many of such parts any Sine, Tangent, or Secant of any Ark or Angle doth contain. Now this is ready done to our Hands, in the Table of Sines, Tangents, and Secants, which we have, with prodigious Industry, in Books ready calculated for this purpose.



12. When therefore any Triangle is given to be resolved, the first thing we have to do, is to consider, that there is in the Table of Logarithms, Sines, Tangents, and Secants, a Triangle exactly similar, and equal to that which we are required to solve, and whose Sides are to one another in the very same Proportion of those of the Triangles proposed.

13. We must understand whatever *Ratio* one Side of the Triangle given, hath to the other Side about the same Angle, considered as Lengths estimated or numbered by any known Measure, as suppose Inches, Yards, Miles, Leagues, &c. the very same hath the two Sides about the same Angle in the Triangles in the Tables, or in the Tabular Parts: Which two things well understood, do lead us into the whole Mystery of Trigonometrical Calculations.

14. *Trigonometry*, is either *Plain* or *Spherical*; and both may be resolved by the means of four *Propositions*, which, because of their excellent Use, are called *Axioms*.

15. The first of which relates to *Rectangle Plain Triangles*; and is this.

### AXIOM I.

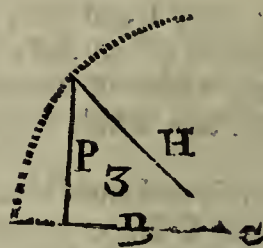
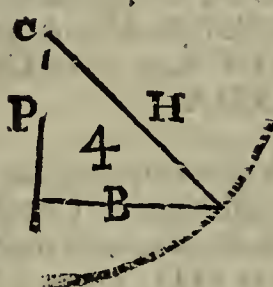
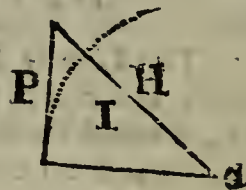
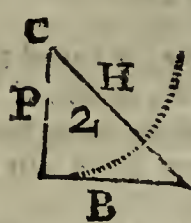
In a Right-angled Triangle, if either of the Legs be supposed to be the Radius of a Circle, the other Leg will be the Tangent of the opposite Angle, or of the Angle of the Centre; and the Hypotenuse will be the Secant of that Angle: But if you imagine the Hypotenuse to be the Radius of a Circle, then each Leg will be the Sine of its opposite Angle, or of the Angle at the Centre; as is plain from the adjoining Figures.

In the first of which B (the Base) being made the Radius P (the Perpendicular) is the Tangent of the Angle at *a*, the Centre of the Circle, which is opposite to P, and the Hypotenuse is the Secant of the same Angle.

In the second Figure, where P is made the Radius, B is the Tangent of the opposite Angle at the Centre *c*.

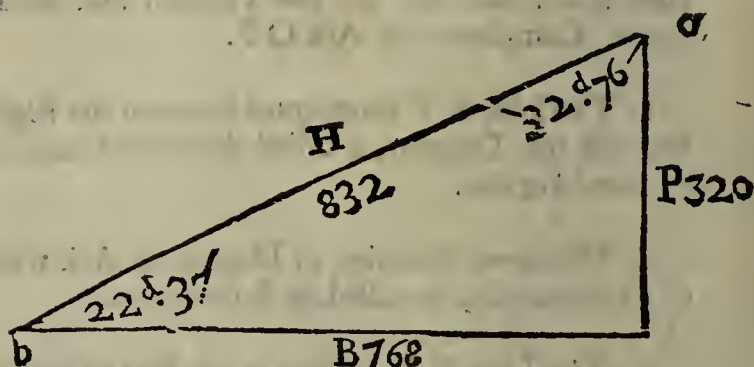
In the third Figure, where H the Hypotenuse is made the Radius, P is the Right-line of the opposite Angle at the Centre. And,

In the fourth Figure, H being also made Radius, but C the Centre of the Circle, B will be the Sine of its opposite Angle *c*.



The seven Cases of Plain Triangles.

|   | Given   | Required. | Proportions.  | Given                     | Required. |
|---|---------|-----------|---|---------------------------|-----------|
| 1 | B, a, b | P         | R : B :: Tan. b : P   | c : √√                    | c         |
| 2 | B, a, b | H         | S, a, B :: R : H  | c : √√                    | b         |
| 3 | B, H    | √√        | H : R :: B : S, a   | c : √ : b                 | √√        |
| 4 | B, H    | P         | H : R :: B : S, a<br>Then R : T : b :: B : P<br>Or R : B :: T : b : P | which finds<br>the √ a,   |           |
| 5 | B : P   | √√        | B : R :: P : T : b  | c √ :   √√                |           |
| 6 | B : P   | H         | B : R :: P : T : b<br>Then S : b P :: R : H                           | by the last.<br>c √ :   b |           |
| 7 | H √√    | B         | R : H :: S, a : B   | b √√                      | c √       |



The Calculation of the Seven Cases of Right-angled Plain Triangles.

### CASE I.

Given B, a, b. Required P?

Canon  $R : B :: T : b : P?$

R = 10.

B = 2.8853612 = 768

T, b = 9.6197205 = 22° 37'

P = 2.5050817 = 320 = P?



The General Rule for all Operations in Trigonometry, is to write down the Numbers found in the Tables according to the Order of the Canon: And then adding together the second and third Numbers, from their Sum subtract the First, the Remainder is the Logarithm of the Term sought.

By Gunter's Line.

Extend the Compasses from 45 Degrees on the Tangents, to 22 Degrees 37 Minutes, the same Extent will reach in the Line of Numbers from 768, backward to 320.

### C A S E II.

Given B,  $a$ ,  $b$ . Required H?

$$\boxed{S, a : B :: R : H?}$$

$$S, a = 9.9652480 = 67^\circ 23'$$

$$B = 2.8853612 = 768$$

$$R = 10.$$

$$H = 2.9201132 = 832 = H.$$

By Gunter's Scale.

Extend the Compasses from 67 Degrees 23 Minutes to 90 Degrees on the Line of Sines; the same Extent will reach from 768 to 832 on the Line of Numbers.

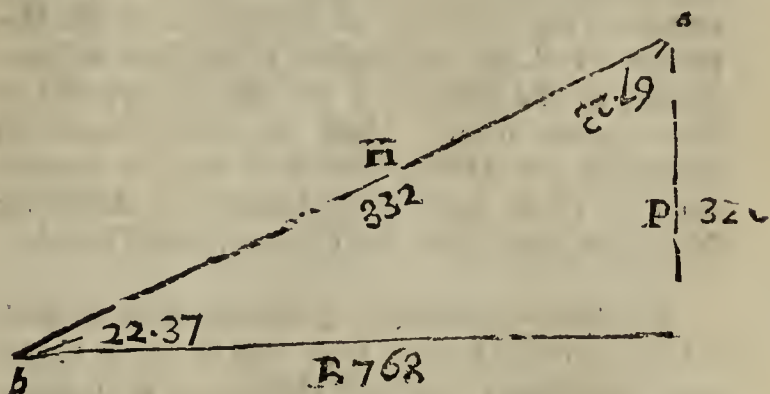
The general Method to state any Case, or to form the Canon.

1. Consider that the Thing sought must always stand in the fourth or last Place: And therefore in Case 1. since P, a Length is sought, that must be the last of the Four Terms; place it therefore last with an Interrogation-point after it, to shew that it is required or sought.

2. In the Golden-Rule the second and fourth Terms being always of the same Nature or Kind, and P being a Length sought, and B the only Length given; B is necessarily determined to be in the second Place: Write it down therefore in that Place with four Points after it thus :: to shew that the Proportion disjoins or breaks off there.

3. Consider that the Hypothenuse not being either given or sought, the first Axiom determines you to work by Tangents: And the Side B given being supposed Radius, the Proportion must be, As B consider'd as Radius, Is to its self considered as a Length given :: So will P considered as the Tangent of the Angle  $b$ , Be to its self considered as a Length sought. That is,

$$\boxed{R : B :: T, b : P?}$$



If the Angle  $b$  had been sought, that must have been placed last, and it would have stood thus; as in Case the Fifth.

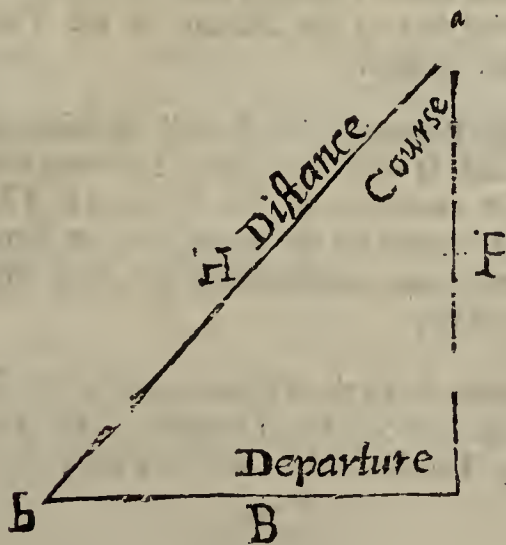
$$\boxed{B : R :: P :: T b?}$$

But if the Hypothenuse had been in the Question, either given or required, you must have worked by Sines, and the Hypothenuse will be always Radius; as in Case 2. where H is sought.

For H being required, it must stand in the last Place; and since B a Length is given of the same Nature with H, that must be in the second Place: And then say by Axiom 1, As B considered as the Sine of the given Angle  $a$ , Is to its self considered as a Length :: So is H considered as Radius, To its self as a Length sought: That is,

$$\boxed{S, a : B :: R : H?}$$

And to shew the extensive Use of this Doctrine of Plain Trigonometry, the General Triangle above described and numbered, may either first relate to the Sea, and then these 7 Cases will be all the Cases of Plain Sailing; and also of Mr. Wright's, or, as 'tis commonly, tho' falsely called, Mercator's too; regard being first had to the way of Working by Meridional Parts, &c.



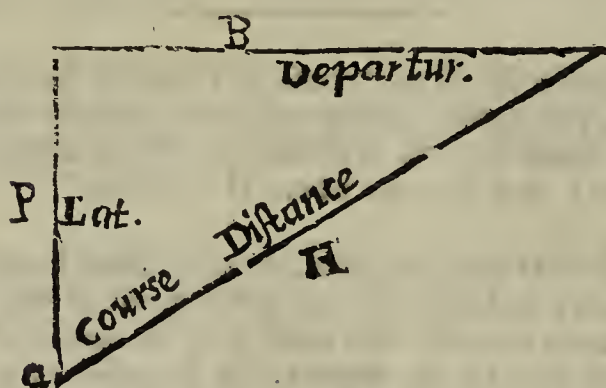
For in this Triangle the Angle  $a$  is the Angle of the Rhumb, or the Angle which the Line of the Ship's Course makes with the Meridian, and therefore usually by the Sailors called *The Course*; and the Side P represents the Meridian of any Place, across which the Ship is supposed to sail; and consequently on it must be accounted the Difference of Latitude between the two Places  $a$  and  $b$ . The Angle  $b$  is the Complement of the Course, or what



what that Angle wants of 90 Degrees, and consequently known when the Course is so. The Base represents the Difference of Longitude, or the Departure West, or the Westing of the Ship in Comparison of the Place at *a* that she is supposed to have parted from : And the Hypothenuse *H* represents the Distance sailed or *run* (as the Seamen call it) or how many Leagues or Miles the Ship hath sailed from the Place *a* to the Place *b*.

This being understood, if this first Case be made a Case of *Plain Sailing*, there will be given Course and Departure ; required Difference of Latitude and the Canon is ;

As Radius is to the Departure in Miles :: So is the Co-tangent of the Course, To the Difference of Latitude in Miles.



*N. B.* Here the Ship being at *a*, is supposed to sail South-Westward (or to speak exactly, W. S. W.) and therefore her Difference of Latitude is reckoned to the South, and her Departure to the West : But by inverting the same Triangle, you may suppose the Difference of Latitude North, and the Departure East ; for the North is accounted to lie right before you, and consequently the East to the Right-hand, and the West to the Left ; wherefore the Course now is E. N. E.

2. If you would apply the Doctrine of *Trigonometry* to the Calculation of Heights, Depths, Distances, the same Triangle and Numbers will do ; regard being had to the Nature of the Terms required and sought.

For the Perpendicular *P*, will represent any Altitude ; and *B* will represent a Distance from the Foot of it measured on the Ground : The Angle at *b* is found by the Quadrant, or some such Instrument ; and consequently you may find *P* by *Case 1*. For,

As Radius is to the Distance, from the Foot of the Object :: So is the Tangent of the Angle of Altitude, To the Height of the Place, *i. e.*

$$R : B :: T, b : P ?$$

Or, suppose the Distance *B* were required from above, by taking the Angle *a*, and finding the Length of *P* by a String and Plummets. Then will

$$R : P :: T, b : P ?$$

This being premised as to the general Use of *Trigonometry*, let us proceed to

### CASE III.

Given *B*, *H*. Required the Angles, *a*, *b*.

$$H : R :: B : S, a ?$$

$$H = 2.9201233 = 832$$

$$R = 10.0000000$$

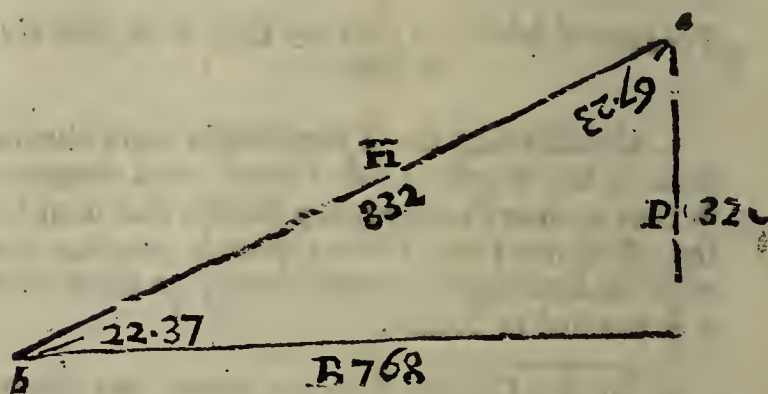
$$B = 2.8853612 = 768$$

$$S, a = 9.9652379 = 67^{\circ} 23' = \text{Angle } a$$

Which subtracted from 90 Degrees, gives the Angle *b* = 22 Degrees, 37 Minutes.

By Gunter's Scale.

The Extent from 832, back to 768, in the Line of Numbers will reach from 90 Degrees to 67 Degrees 30 Minutes in the same Line of Sines.



### CASE IV.

Given *B*, *H*. Required *P*?

Having found *a* by the foregoing Case, this will be the Theorem :

$$R : B :: T : b : P ?$$

Or,

$$R : T, b :: B : P ?$$

*R* =



$$R = 10.$$

$$T, b = 9.6197205 = 22^\circ 37'$$

$$B = 2.8853612 = 768$$

$$P = 2.5050817 = 320.$$

By Gunter's Scale.

The Extent from 45 Degrees in the Tangent-line, back to 22 Degrees 37 Minutes, will reach in the Line of Numbers from 768, back to 320.

### CASE V.

Given B, P. Required  $\angle$ ?

$$B : R :: P : T, b?$$

$$B = 2.8853612 = 768$$

$$R = 10.$$

$$P = 2.5051500 = 320$$

$$T, b = 9.6197888 = 22^\circ 37' = b.$$

Which 22 Degrees 37 Minutes subtracted from 90 Degrees, leaves  $a = 67$  Degrees 23 Minutes.

By Gunter's Scale.

The Extent from 768 back to 320, in the Line, will reach from 45 back to 22 Degrees 37 Minutes in the Tangents.

### CASE VI.

Given B, P. Required H?

Having found  $b$  by the foregoing Case, this will be the Theorem:

$$S, b : P :: R : H?$$

$$S, b = 9.5849685 = 22^\circ 37'$$

$$P = 2.5051500 = 320$$

$$R = 10.$$

$$H = 2.9201815 = 832 = H?$$

By Gunter's Scale.

The Extent from 22 Degrees 37 Minutes, forwards, to 90 Degrees in the Line of Sines, will reach from 320, to 832 in the Line of Numbers.

### CASE VII.

Given H and  $\angle$ . Required H?

$$R : H :: S, a : B?$$

$$R = 10.$$

$$H = 2.9201233 = 832$$

$$S, a = 9.9652480 = 67^\circ 23'$$

$$B = 2.8853719 = 768 = B.$$

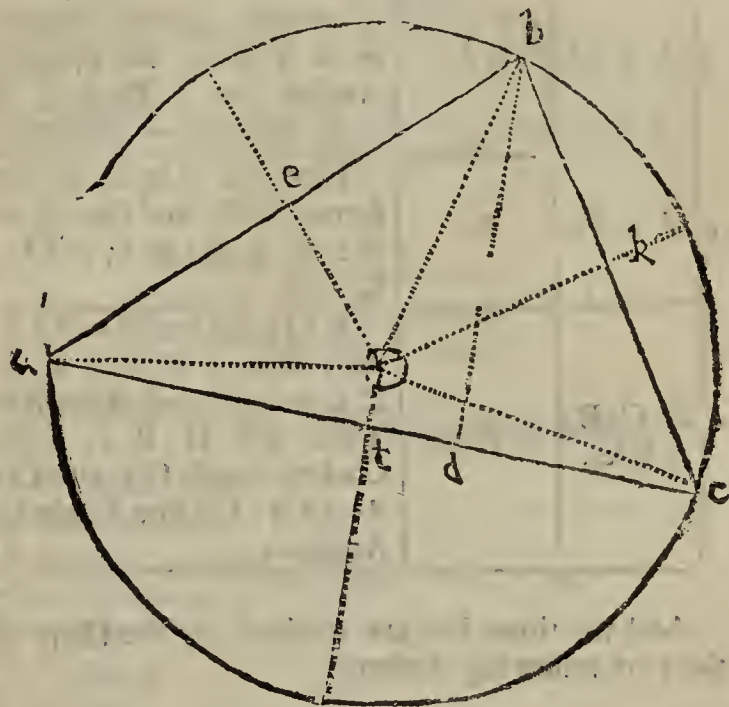
By Gunter's Scale.

The Extent from 90 Degrees in Line of Sines, back to 67 Degrees 23 Minutes, will reach in the Line of Numbers from 832 backwards to 768.

The Resolution of Oblique Plain Triangles.

### AXIOM II.

In every Triangle,  $a, b, c$ , the Sides are in Proportion to one another, as the Sines of their opposite Angles.



Let fall from the Angle  $b$ , a Perpendicular to the Base  $ac$ : For then the whole will be resolved into two Right-angle Triangles, and consequently by Axiom the First  $ab : R :: bd : S, a$ ; also  $bc : R :: bd : S, c$ ; wherefore  $ab : bc :: S, c : S, a$ : by Reciprocity of Proportion.

Otherwise thus:

Draw a Circle about the Triangle, from whose Centre  $O$ , let the Perpendiculars,  $Oe$ ,  $Ok$ , and  $Ot$ , be let fall to the three Sides of the Triangle, and the Lines  $oa$ ,  $ob$ , and  $oc$ , be drawn to the three Angles.

The Sides of the Triangle will be bisected by the Perpendiculars, and consequently  $ae$  will be  $= eb$ ,  $bk = kc$  and  $ct = ta$ ; wherefore as the whole Line  $ab$ , is to  $bc$ : so will the half Side  $ac$  be, to the half  $kc$ ; but  $ae$  and  $kc$ , are the Sines of the Angles at the Centre  $aoe$  and  $koc$ , which Angles at the Centre are severally equal to the Angles of the Triangle  $c$  and  $a$ , because they stand on half the Arks that the Angles of the Triangle do; wherefore  $ab : bc :: S, c : S, a$ .

Let  $H, B$ , and  $O$ , be the Sides of an Oblique Plain Triangle;  $a, b$  and  $c$ , its three Angles: Here because there is no Right-angle, three Things must be always given, that is, either two Sides and one Angle, one Side and two Angles, or else all the three Sides.



From whence will arise the three former of the fix following Cafes.

| Given.                 | Required. | Proportions.   |
|------------------------|-----------|--|
| 1 H. O. c.             | b.        | O, S c :: H : S, b. Note, that the Angle b is ambiguous, and you must collect from the Circumstances of the Triangle, whether it be Obtuse or Acute.   |
| 2 H. O. c.             | B.        | Here first find the Angle b by <i>Cafe 1.</i> thence a will be known by taking the Sum of $b + c$ from $180^\circ$ . Then S, c : O :: S, a : B. Or S, b : H :: S, a : B.                                     |
| 3 c, b, O.             | H.        | S, c : O :: S b : H.   |
| 4 H. a. O.             | c, b.     | $A + O : H - O :: T \frac{1}{2}$ Z of the opposite Angles, to $T \frac{1}{2}$ X of the opposite Angles, and $\frac{1}{2} Z + \frac{1}{2} X = b$ , and $\frac{1}{2} Z - \frac{1}{2} X = c$ .                  |
| 5 H. a, O.             | B.        | Find the Angles by the former Case, and then S, b : H :: S, a : B; or S, c : O :: S, a : b.  |
| 6 H. O. B.<br>3 Sides. | 3 Angl.   | $B : H + O :: H - O : X$ . And then $\frac{1}{2} B + \frac{1}{2} X = C B$ and $\frac{1}{2} B - \frac{1}{2} X = B b$ . Then will H : R :: C B : Co-sine Angle C; and O : R :: b B : Co-sine Angle b; Axiom 1. |

And the three last are resolved by the Help of the two following Axioms:

### A X I O M III.

*As the Sum of the Legs about the Angle given, is to their Difference :: so is the Tangent of half the Sum of the other two Angles, to the Tangent of half their Difference.*

Now the Sum of the other two Angles is known, being what the given Angle wants of  $180$  Degrees, and their Difference is now found; add therefore their half Sum, and half Difference together, and it gives you the greater of the two Angles sought; and half the Difference subtracted from the half Sum, leaves the lesser Angle sought. And thus having found the Angles, if the Side opposite to the former given Angle be sought, it will be found easily by *Pardie's Axiom*, that the Sides are as the Sines of the Angles.

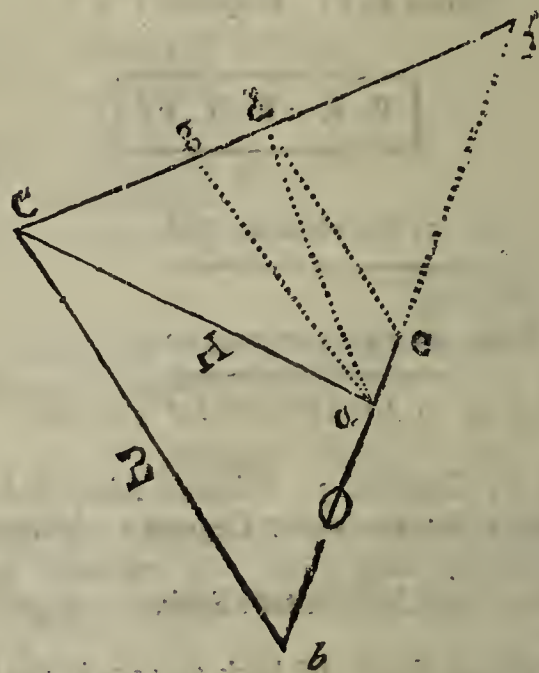
The Demonstration of the *Third Axiom*, is briefly thus.

#### Demonstration.

I say the Sum of the Legs of any Angle a, is to their Difference :: as the Tangent of half the Sum of their opposite Angles, is to the Tangent of half their Difference.

Produce O, one of the given Legs of the Angle given, 'till af become equal to H or Ca, and then bisect bf in e; join cf, and bisect it also in d: Draw ad, which will be perpendicular to cf (2. 16.) and draw de, which will be parallel to cb. (6. 92.) Then will the Angle cad = daf; i. e. to the half of caf, which external Angles caf = c + b: That is, to the Sum of the opposite Angles required.

Draw then ga parallel to cb; so will the Angle gac be equal to the alternate one c. And if from half the Sum of the opposite Angles you take the lesser Angle; i. e. If from cad, you take gac, there will remain the Angle gad, equal to half the Difference of the opposite Angles.



And so also, if from be, half the Sum of the Legs, you take O the lesser Leg, there will remain ae equal to half the Difference of the Legs. And then since the Triangle cad is Right-angled, if ad be made Radius, cd will be the Tangent of the Angle cad (i. e. the Tangent of half the Sum of opposite Angles;) and in the little Triangle gad, gd will be the Tangent of the Angle gad (i. e. The Tangent of half the Difference of opposite Angles.) But the Segments of the Legs of any Triangle cut by Lines parallel to the Base, being proportionable, eb : ea :: cd : dg; That is, in Words, *Half the Sum of the Legs, is to half their Difference :: as the Tangent of half the Sum of the opposite Angle, is to the Tangent of half their Difference;* but Wholes are as their Halves: Wherefore the Sum of the Legs, is to their Difference :: as the Tangent of half the Sum of the opposite Angles, is to the Tangent of half their Difference. Q. E. D.

Whence the two following Cafes will easily be solved.

### C A S E I.

Given H, O and a. Required c, b?

For  $H + O : H - O ::$  as T, half Z opposite Angles, is to T, half X opposite Angles; and then half Z + half X = b, and half Z - half X = c.

### C A S E



## C A S E II.

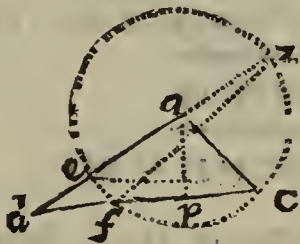
Given H, O, and  $a$ . Required B?

First find the Angles by the former *Cafe*, and then  $S, b : H :: S, a : B$ ; or  $S, c : O :: S, a : B$ ; by the *Second Axiom*.

## A X I O M IV.

The Base, is to the Sum of the Legs :: as the Difference of the Legs, is to the Difference of the Segments of the Base made by a Perpendicular let fall from the Angle opposite to the Base.

For there is also another *Cafe*, in plain Oblique-Triangles, which requires a particular Axiom to solve it; and that is, Where all three Sides are given, to find the Angles. Here let fall a Perpendicular from any Angle to its opposite Side, as  $ap$ ;



and then say, As the Side  $dc$ , is to  $da + ac$ , the Sum of the other two Sides :: so is the Difference of those two Sides  $da - ac$ , To a fourth Number. Half of which added to half  $dc$ , gives you the Segment of the Base  $dp$ ; and if subtracted from half  $dc$ , it will leave the other Segment  $pc$ . And when those Segments are thus found, the Angles are easily had thus;  $da : Radius :: dp : \text{Co-fine of the Angle } d$ , and  $ac : Radius :: pc : \text{Co-fine of the Angle } C$ .

The Demonstration of which last Axiom, is thus.

*Demonstration.*

On the Centre  $a$ , with the Distance  $ac$ , describe a Circle, which will intersect both the other Sides of the Triangle, and then  $zd$  will represent the Sum of the Legs  $da$  and  $ac$ ;  $de$  will represent their Difference, and  $df$  will represent the Difference of the Segments of the Base made by the Fall of the Perpendicular  $ap$ .

Then I say,  $dc : dz :: de : df$ ; That is, The Base, is to the Sum of the Legs :: as the Difference between the two Sides, is to the Difference of Segments of the Base; as is apparent from Prop. 67. of *Pardie's Sixth Book*, after drawing the prick'd Lines  $ec$  and  $fz$ .

And then the *Cafe* will stand thus.

## C A S E III.

Given H, O, B, all three Sides. Required the Angles? See the Figures before.

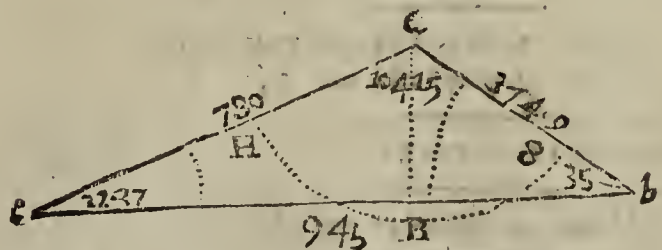
I say, by this *Axiom*,  $B : H + O :: H - O : X$ , which expresses the Difference of the Segments of the Base  $= ef$  in the Figure.

And then having found X; half B + half X =  $dp$  the greater Segment, and half B - half X =  $pc$ , the lesser, by which means the two Right-angled Triangles  $adp$ , and  $apc$ , will be solved easily: For  $da : Radius :: dp : \text{Co-fine of the Angle } d$ ; And  $ac : Radius :: pc : \text{Co-fine of the Angle } c$ .

The Operation of the Six Cafes of Oblique-angled Triangles.

## C A S E I.

Given H, O,  $c$ . Required  $b$ ?



$$O : S, c :: H : S, b ?$$

The Numbers of the Triangles, are as follow.

$$\begin{aligned} \sqrt{c} &= 22^\circ 37' \\ \sqrt{b} &= 53 \ 08 \\ \sqrt{a} &= 194 \ 15 \text{ Or, its Suppl.} = 75^\circ 45' \end{aligned}$$

$$\begin{aligned} H &= 780 \\ O &= 374.9 \\ B &= 945 \\ O &= 2.5739154 = 347.9 \end{aligned}$$

$$\begin{aligned} S, c &= 9.5849685 = 22^\circ 37' \\ H &= 2.8920946 = 780 \end{aligned}$$

$$\text{Sum} = 12.4770631$$

$$S, b = 9.9031477 = 53^\circ 8'$$

## C A S E II.

Find first the Angle  $c$ , by *Cafe* I. then will  $a$  be known.

Given H, O,  $c$ . Required B?

$$S, c : O :: S, a : B ?$$

$$S, c = 9.5849685 = 22^\circ 37'$$

$$\begin{aligned} O &= 2.5739154 = 374.9 \\ S, a &= 9.9864273 = 104 \ 15 \end{aligned}$$

$$\text{Sum} = 12.5603427$$

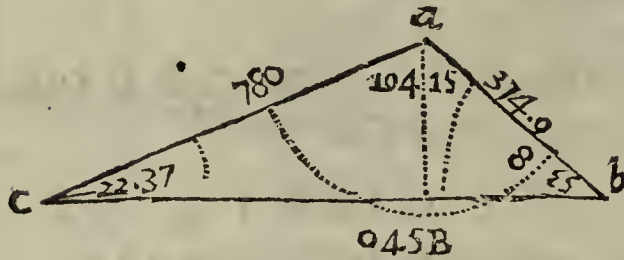
$$B = 2.9753742 = 945$$



# TRI

## CASE III.

Given  $c, b, O$ . Required  $H$ ?



$$S, c = 9.5849685 = 22^\circ 37'$$

$$O = 2.5739154 = 374 \quad 9$$

$$S, b = 9.9031084 = 53 \quad 8$$

$$\text{Sum} = 12.4770238$$

$$H = 2.8920553 = 780$$

## CASE IV.

Given  $H, a, O$  Required  $b, c$ ?

$$H+O : H-O :: T, \frac{1}{2} Z. \text{op.} \sqrt{\sqrt{}} : T, \frac{1}{2} X \text{op.} \sqrt{\sqrt{}}$$

$$H+O = 1154 \quad 9$$

$$H-O = 405 \quad 1$$

$$\text{Half } Z \text{ opposite Angles} = 37 \quad 52$$

$$H+O = 3.0625820 = 1154 \quad 9$$

$$H-O = 2.6074550 = 405 \quad 1$$

$$T \text{ half } Z = 9.8907254 = 37 \quad 52$$

$$\text{Sum} = 12.4981804$$

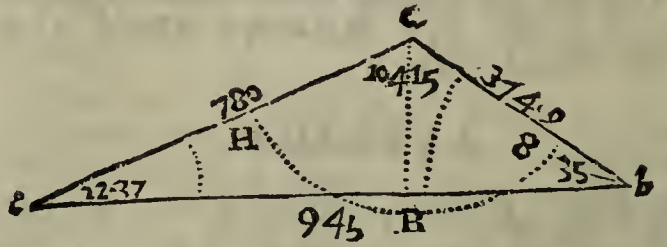
$$T, \text{ half } X. 9.4355984 = 15 \quad 15$$

Then will half  $Z +$  half  $X = 53$  Degrees 7 Minutes  $= b$ ; and half  $Z -$  half  $X = 22$  Degrees 37 Minutes  $= c$ .

# TRI

## CASE V.

Given  $H, a, O$ . Required  $B$ ?



Find the Angles  $b$  and  $c$ , by Case 4. then,

$$S, b : H :: S, a : B$$

$$S, b = 9.9031084 = 53^\circ 8'$$

$$H = 2.8920946 = 780$$

$$S, a = 9.9864273 = 104^\circ 15' *$$

$$\text{Sum} = 12.8785219$$

$$B = 2.9754135 = 945$$

\* This is the Sine of  $74.45$ , the Supplement of  $104.15$ , to a Semi-circle.

## CASE VI.

Given  $H, O, B$ . Required Three Angles?

$$B : H+O :: H-O : X.$$

$$\frac{1}{2} B + \frac{1}{2} X = C B \text{ and } \frac{1}{2} B - \frac{1}{2} X = B b.$$

$$H : R :: B c : \Sigma c; \text{ and } O : R :: B b : \Sigma b.$$

$$B = 2.9754318 = 945$$

$$H+O = 3.0622058 = 1154.9$$

$$H-O = 2.6074540 = 405.1$$

$$\frac{1}{2} B = 472 \frac{1}{2}$$

$$\frac{1}{2} X = 247 \frac{1}{2}$$

$$5.6696058 =$$

$$2.6942280 = 495$$

$$H = 2.8920453 = 780'$$

$$\frac{1}{2} B + \frac{1}{2} X = 750$$

$$\frac{1}{2} X - \frac{1}{2} B = 225 \quad R = 10.$$

$$B C = 2.8573225 = 720$$

$$\Sigma c = 9.9652672 = 23^\circ 37'$$

$$O = 2.5739154$$

$$R = 10.$$

$$B b = 2.3521825$$

$$\Sigma b = 9.7782671 = 53^\circ 08'$$

And when thus the Nature, Reason, and Method of Operation in the Calculating of the Sides and Angles of Oblique Triangles, is fully understood;

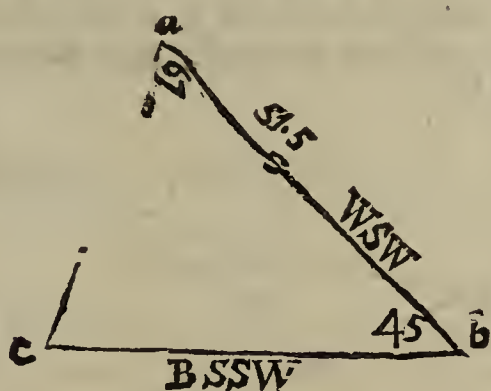


stood ; its Application, Use, and Practice, will be very easy and plain, tho' its Extent be very large and ample. For,

*First*, If you have a Mind to apply it to what they call *Oblique Sailing*, or the Doctrine of *Oblique Plain Trigonometry*, applied to *Sailing*, your former Triangle and Cases will reach all that you can desire.

As suppose a Ship Coasting along by the Shore from the Place *b*, sets an Head-Land by her Compass (as *c*) and finds it to bear from her S. S. W. then she fails on W. S. W. 51. 5 Miles or Minutes to *a* ; and then finds that the Head-Land bears from her full S. E.

'Tis required to determine her Distance from this Head-Land when she was at *b*, and now she is at *a*.



First, To Plot the Triangle.

Draw a straight Line, as *B*, representing the first Bearing of the Head-Land, which was S. S. W. Then from 6 Points take 2, and there remains 4 = 45° ; because the Ship failed West-South-West, make the Angle *b* equal to 45°, and so will the Line *O* represent the Distance failed, and *b* will be the Course. Prick off the Distance run, viz. 51. 5 Miles from *b* to *a*. Then, because the Ship failed W. S. W. the contrary Rhumb from *a* to *b* must be E. N. E. And since the South-East Rhumb makes with that an Angle of 67° 30', you must make the Angle at *a*, just 67° 30'. So with the Line *H*, when drawn, intersect the Line *B* in the Point of the Situation of the Head-Land *c* ; and by that means will the Triangle be completed.

This being done, if you please, (tho' plotting the Triangle is not of absolute Necessity, but very useful and instructive) then consider, that it must be a Case of *Oblique Plain Triangles*, where is given the Angle *a* and *b*, and the Side *O*. Required *H* and *B* ?

To find *H*, say, (because *c* is also known if *a* and *b* are)

$$\boxed{S, c : O :: S, b : H}$$

Operation.

$$S, c = 9.9656153 = 67^{\circ} 30'$$

$$O = 1.7118072 = 51.5 \text{ Miles}$$

$$S, b = 9.8494850 = 45^{\circ}$$

$$\text{Sum} = 11.5612922$$

$$H = 1.5956769 = 39.4 \text{ Miles}$$

And to find *B*, you may say,

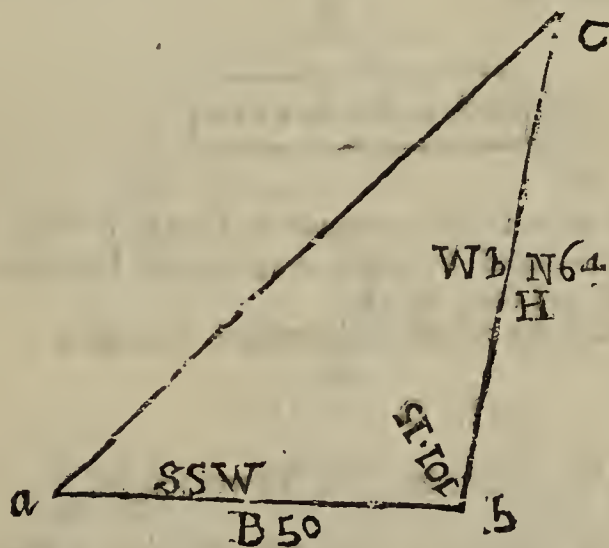
$$\text{As } S, b : H :: S, a : B ?$$

Or,

$$\text{As } S, c : O :: S, a : B ?$$

I shall give but one Instance more in this Matter, which is this.

Suppose a Ship sail S. S. W. 50 Leagues, and then W. by N. 64 Leagues : What was her direct Course, and what is her Distance from the Place she went from ?



To Plot the Case.

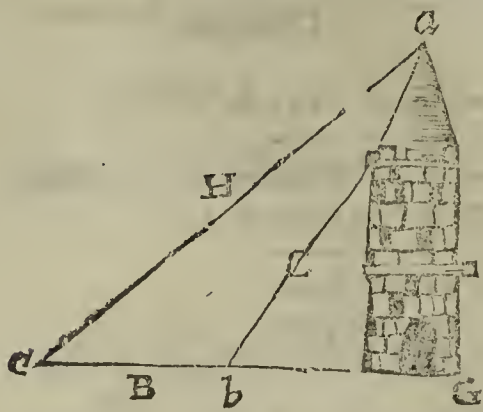
Let *b* be the Place from whence the Ship failed, and let *B* represent the S. S. W. Rhumb, and the Distance thereon run = 50 Leagues, from *b* to *a*.

Then, since the first Course was two Points, and the Second seven Points from the Meridian, make an obtuse Angle at *b* equal to 9 Points, 101° 15' : And on the Leg *H* set 64 Leagues ; then drawing the Side *a c*, the Triangle will be formed.

In which you have two Legs, *H* and *B* forming the Angle *a*, and that Angle given. And this is Case 4. of *Plain Oblique Triangles*.

Secondly, If you would apply this Part of *Trigonometry* to the Measuring of inaccessible Distances, Heights, &c. at Land ; the Practice will be very easy.





Suppose a Tower, Steeple, &c. as  $aG$ , whose Height you would take, but can measure no nearer than from  $c$  to  $b$ , but know the Length  $B$  is = 100 Yards.

Here you can take the Angle  $abG$  with your Quadrant, and consequently the obtuse contiguous one,  $cb a$ , is known.

The Angle  $c$  is known after the same way by the Instrument: Wherefore having in the obtuse-angled Triangle  $HO B$ , the Base  $B$ , and the Angles  $c$  and  $b$ , you must find  $O$  by *Case 3. of Oblique Plain Triangles*: For since  $c$  and  $b$  are known, their Sum subtracted from 180, will leave  $c a b$ , known. Therefore say,

$$\text{As } S, a : B :: S, c : O.$$

And when it is thus known or found, having in the Right-angled Triangle,  $b a, G$ , the Hypotenuse  $O$ , and the Angle  $b$ .

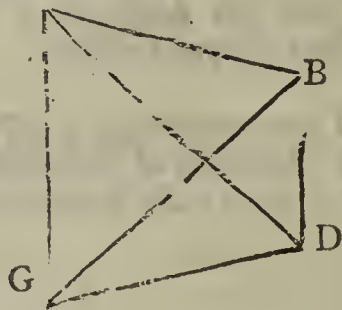
By *Case the 7th of Right-angled Triangles*,

$$\text{As } R : O :: S, b : a G.$$

The Altitude of the Tower sought.

*Thirdly*, Suppose an inaccessible Distance, as  $BD$ , which imagine to be the Distance between two Forts, Bastions, &c. on the Wall or Line of an Enemies City or Camp; and that because of the Cannon, &c. you can go no nearer than the Line  $GC$ , but can measure them from  $G$  to  $C$ , and at each Station take Angles with an Instrument.

Having taken then, by the Theodolite, &c. the Angles  $GCD$ , and  $CGD$ , and measured  $GC$ ; and also having taken the Angles  $CGD$ , and  $BCG$ . This premised, which is easily done by the Instrument,



You have in the Triangle  $CBG$ , the Side  $CG$ , and the two Angles  $G$ , and  $GC B$ ; wherefore also the Angle  $CBG$ . Say therefore,

$$\text{As, } B : GC :: S, C : GB:$$

And consequently  $GB$  is found.

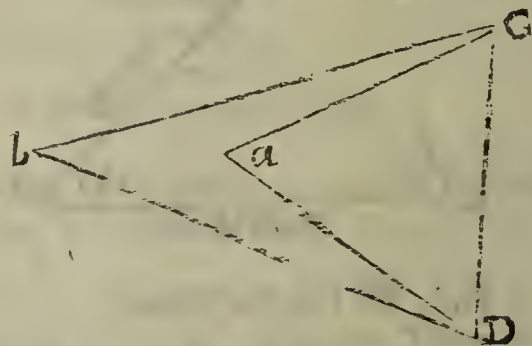
Again, in the Triangle  $CDG$ , the Angles  $GCD$ ,  $CGD$ , and the Side  $CG$  being given, the Side  $GD$  will be found by this Proportion:

$$\text{As } S, D : CG :: S, C : GD:$$

And consequently  $GD$  also is found.

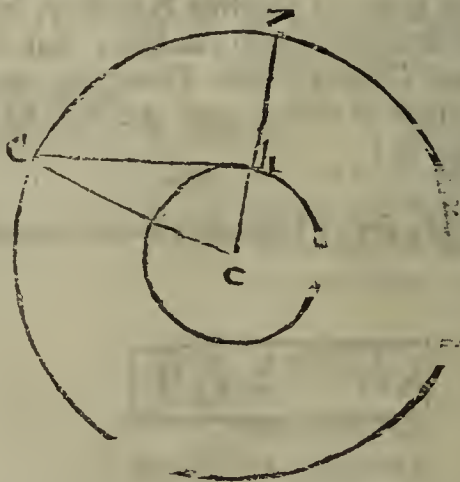
And now having in the Triangle  $GBD$  the two Sides  $GB$  and  $GD$ , and the included Angle  $G$ , you can first find the remaining Angles severally by *Axiom 3.* and then the Side  $BD$  by *Axiom 2.*

Or, If not being able to get nearer than the Point  $a$ , you could not measure sideways as before, but only backward to  $b$ , or forward from  $b$  to  $a$ ; you may then easily gain the Length from  $D$  to  $C$ .



For placing the Instrument at  $a$ , you can take the two Angles  $b a D$  and  $b a C$ , and take also  $C a D$ ; measure then from  $a$  to  $b$ , and at  $b$  take also the two Angles  $a b D$ , and  $a b C$ . Then can you easily gain the Sides  $a C$  and  $a D$ , in the two Triangles  $b a C$  and  $b a D$ ; and having before taken by the Instrument the Angle  $C a D$ , you may find the Side  $CD$  in that last Triangle  $a C D$ , by the second and third *Axioms of Plain Oblique Trigonometry*. Also,

*Fourthly*, On the Application of this Part of *Trigonometry* to the Doctrine of *Astronomy*, depends the Method for finding the Parallax and Distance of a Planet or Star.



Let  $c$  be the Centre of our Earth, and  $h$  a Point on its Surface, at which an Observer at  $h$  takes with an Instrument the Angle  $h b z$ , or the Distance of the Meridian Moon  $h$ , from her Zenith at  $z$ . Her



Her true Distance from the Zenith is known by the Astronomical Tables, which is the Angle  $\angle c z$ : But the observed Angle  $\angle h z$  being external to the Triangle,  $\angle h z$  will be  $\equiv$  to  $\angle + c$ .

Where take  $c$  from it, and the Remainder is the Angle  $h \angle c \equiv$  to the Moon's Parallax, whose Subtense is  $h c \equiv$  to the Earth's Semi-diameter.

Suppose that  $h c$  be 4000 Miles; then in the Triangle  $\angle h c$  there are all the Angles and the Side  $h c$  known.

Wherefore,

$$\text{As } S, \angle : h c :: S, b : \angle c;$$

Which is the Moon's Distance from the Centre of our Globe.

And also, as

$$S, \angle : h c :: S, c : \angle b;$$

The Moon's Distance from the Place of Observation.

## TRIGONOMETRY Spherical.

### Definition 1.

A *Spherical Triangle* is made by, or contained under the Arks of three great Circles of the Sphere.

### Definition 2.

A *Spherical Angle* is the mutual Inclination or Aperture of the Planes of two great Circles.

### Properties of Spherick Triangles.

1. When one Circumference of a Circle cuts, crosses, or falls on another, the Sum of the Angle made thereby is equal to two right ones.

2. When two Circumferences of Circles cross each other, tho' opposite and vertical Angles, are always equal.

3. In every *Spherical Triangle*, the greater Angle is opposite to the greater Side.

4. An *Isoceles Spherical Triangle* hath its Angles at the Base equal to each other; the *Converse* of which also is true, That if the Angles at the Base are equal, the Triangle is an *Isoceles*.

5. If two *Spherical Triangles* are mutually *Equilateral*, they are also *Equiangular* and *Similar* one to another.

6. If two *Spherick Triangles* have in each one Angle and two Sides including it; or if they have one Side and two Angles adjacent respectively equal, the whole Triangles are equal.

7. Any two Sides of a *Spherick Triangle* are longer than the Third; because the Ark of a great Circle is the nearest Distance between any two Points on the Sphere.

8. All great Circles must cut each other into two equal Parts, because their common Intersection is a Diameter of the Sphere; and consequently the two Points of Intersection are at the Distance of a Semicircle from each other.

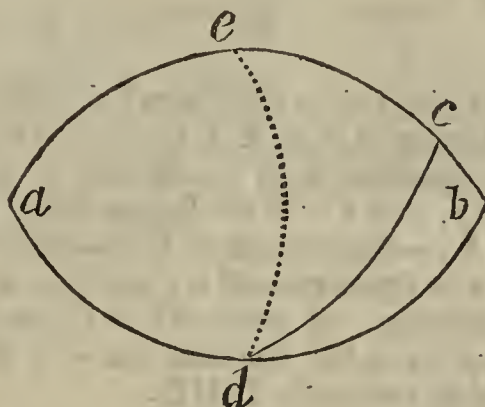
## COROLLARY.

Hence 'tis plain, That every Side of a Spherick Triangle must be less than a Semicircle.

9. The opposite Angles at the Intersection of two Circles are always equal, because the same Planes constitute both Angles; that is, the Angle  $a$  is equal to the Angle  $b$ : See Figure below.

10. In a *Spherical Triangle*, if the Sum of the Legs of any Angle be greater, equal, or less than a Semicircle, the internal Angle at the Base is accordingly greater, equal, or less than the outward and opposite one; and consequently the Sum of the two internal Angles at the Base is greater, equal, or less than two Right Angles.

## DEMONSTRATION.



If  $ac + cd$  be greater than  $ab$ ,  $dc$  must be longer than  $cb$ , and consequently the Angle  $b$  ( $= a$ ) will be bigger than the Angle  $cdb$ . *Property 3.* But if  $ac + cd$  be equal to a Semicircle, then  $dc$  will be equal to  $cb$ , and the Angle  $b \equiv$  Angle  $cdb$ . And in the Triangle  $dcb$ , because  $dc + cd$  is less than  $ab$ ; therefore  $ac$  is greater than  $cd$ , and consequently the external Angle  $adc$  is greater than the Angle  $a$ ; that is, than the Angle  $b$ , the internal Angle at the Base.

Also, since the Angle  $adc +$  the Angle  $Cdb \equiv$  two Right Angles, therefore the Angle  $adc +$  the Angle  $a$  is greater than two Right Angles, &c.

11. In an *Isoceles Sph. Triangle*, if one of the equal Legs is greater, equal, or less than a Quadrant, the Angle is accordingly greater, equal, or less than a Right one.

12. The Sum of the three Sides of every *Sph. Triangle* is less than a Circle.

For  $cd$  is less than  $cb + bd$ ; wherefore  $ac + dc + da$ , must be less than the Sides  $acb + adb$ : See the Figure above.

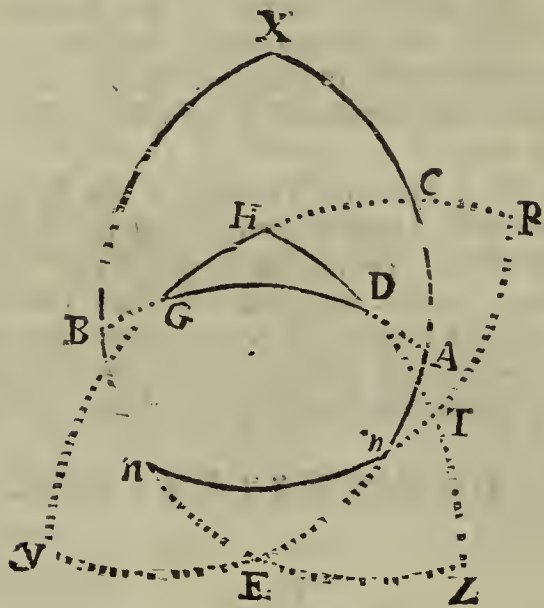
13. The Measure of any *Spherick Angle* is an Ark of a great Circle described from the Angular Point, and precisely 90 Deg. distant from it; that is, making the Angular Point the *Pole* of that Circle.

14. The



14. The Poles of the Sides of any Triangle  $GHD$ , do on the Surface of the Globe constitute another Triangle  $nxm$ , which may be called Supplemental to the Triangle  $GHD$ ; for the Supplements of the Angles and Sides of the Triangle  $nxm$  are equal to the Sides and Angles of the Triangle  $GHD$ .

### DEMONSTRATION.



From the Points  $GHD$ , as Poles describe three great Circles  $xAy$ ,  $RTmn$ ,  $xBnz$ ; then is  $ym = \text{Quadrant} = Ax$ ; because  $m$  is the Pole of  $HGy$ , and  $x$  or  $E$  the Pole of  $GA$ ; therefore  $mx = Ay = \text{Supplement of } CA = \text{Angle } HGD$ , and  $zn$  is  $\text{Quadrant} = Bx$ ; therefore  $nx = Bx = \text{Supplement of Angle } GHD$ , and  $nt = \text{Quadrant} = mR$ ; therefore  $nm = TR = \text{Supplement of the Angle } DHG$ .

*Note*, That the Triangle  $nEm$ , constituted between the three next Poles, has its three Sides and Angles equal to the Angles and Sides of the Triangle  $GHD$ , save that the greatest Side  $nm$  is the Supplement of the greatest Angle  $H$ , and the Angle  $E$  the Supplement of the Side  $GD$ .

15. Any Angle of a Triangle, with the Difference of the other two, is less than two Right Angles. For,  $xn$  is less than  $xm + mn$ :

That is,

$$2L - D < 2L - G + 2L - H.$$

Therefore,

$$G + H - D < 2L.$$

For since  $2L - D < 2L - G + 2L - H$ :

That is,

$$2L - D < 4L - G - H,$$

By transferring  $D$ ,  $G$ , and  $H$ , 'twill be  $2L + G + H < 4L + D$ ; then by taking away  $2L$  from both Sides, and transferring  $D$ , you'll have  $G + H - D < 2L$ . Q. E. D.

16. If

16. If two Triangles are mutually Equiangular, they are also mutually Equilateral; for, because they are Equiangular, their Supplemental Triangles are Equilateral, (by 14th.) and therefore Equiangular (by 15th.) and therefore the proposed Triangles are Equilateral (by 14th.)

17. First, The 3 Angles of every Triangle are greater than 2 Right Angles, and less than 6 Right ones.

For  $nx + mx + mn < 4L$  (by 12.)

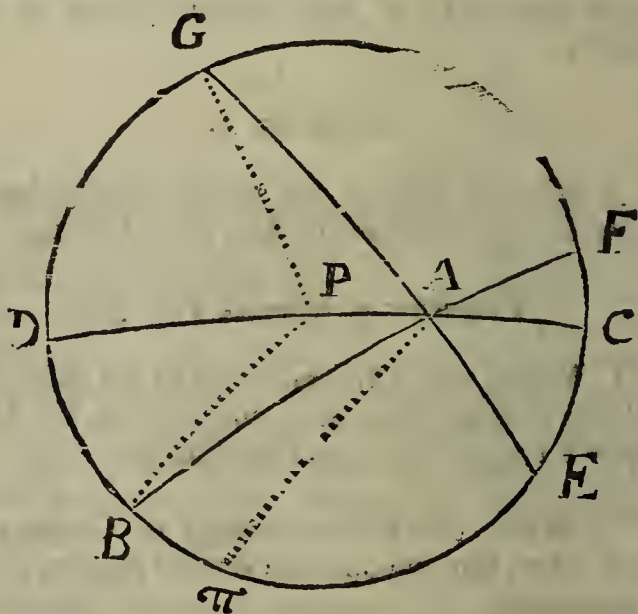
That is,

$$6L - D - G - H < 4L, \\ i. e. 2L < D + G + H.$$

2dly, The Sum of the internal Angles is less than the Sum of the Internal and External, both which, in all, make but six Right Angles.

18. Of several Arks of great Circles falling from the same Point of the Sphere's Surface on another Circle, the greatest is that which passes through the Pole of the Circle, and the next to this is greater than that which is farther off.

For suppose  $P$  the Pole of the Circle  $C\pi D$ , and  $\pi$  the Pole of  $DPC$ ; then is  $AD \angle AB \angle AE \angle AC$ ; and the Arch  $B\pi C \angle BP \angle BD$ .



19. A great Circle passing through the Poles of another great Circle, cuts it at Right-angles; and on the contrary, if it cuts it at Right-angles, it passes through its Poles. Thus the Angle  $PBD = \angle PGD = PDB$ , also = to  $\pi AC$ .

20. In an oblique-angled Triangle, if the Angles at the Base are like, or of the same kind, i. e. both Acute, or both Obtuse, the Perpendicular falls within the Triangle, and the Quadrantal Ark without: But if they be unlike, the Perpendicular falls without, and the Quadrant within. For the Triangle  $EAF$  has the Angles  $E$  and  $F$  Acute, and the Perpendicular  $AC$  falls within, and the Quadrant  $A\pi$  without. Also the Triangle  $BAG$  hath  $B$  and  $G$  obtuse; and the Perpendicular  $AD$  within, and the Quadrant  $A\pi$  without: But the Triangle  $BAE$  has the Angle  $BE$  of different kinds, and the Perpendicular  $AC$  without, and the Quadrant  $A\pi$  within.

Also, by the same Figure is manifest how the Ambiguities of Right-angled Triangles may be solved, viz.

S O L U-



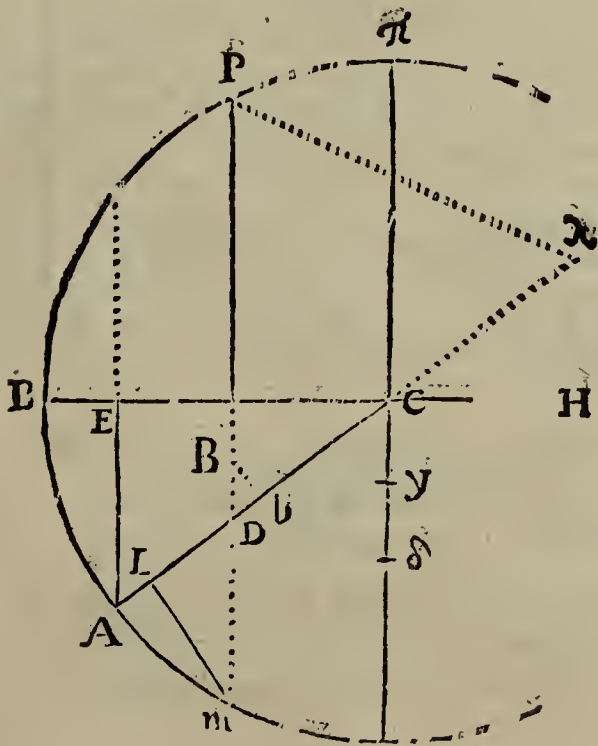
## SOLUTIONS.

1. The Legs of the Right-angle are of the same kind with the opposite Angles. So in the Triangle  $BDA$ , because  $DA$  is greater than a Quadrant  $DP$ , the Angle  $DBA$  is greater than the Right-angle  $DBP$ : And in the Triangle  $BCA$ , because  $AC$  is less than the Quadrant  $PC$ , the Angle  $CBA$  is less than the Right-angle  $CBP$ .

2. If the Legs (and consequently the Angles) are of the same or different kinds; the Hypotenuse is accordingly less or greater than a Quadrant: So in the Triangles  $EAD$ ,  $ECA$ , the Hypotenuse  $AE$  is less than a Quadrant; but in the Triangle  $BDA$ , the Hypotenuse  $AB$  is greater than the Quadrant  $BP$ .

3. If the Hypotenuse is less or greater than a Quadrant, either Leg, with its adjacent Angle, is accordingly of the same or different kind, as follows from the two last.

For the viewing the Sines, Co-sines; and other Right-lines of Arks; which are not visible in a common Sphere; Let the Arks of three great Circles of Card Paste-board be put together, as in an Armillar Sphere:

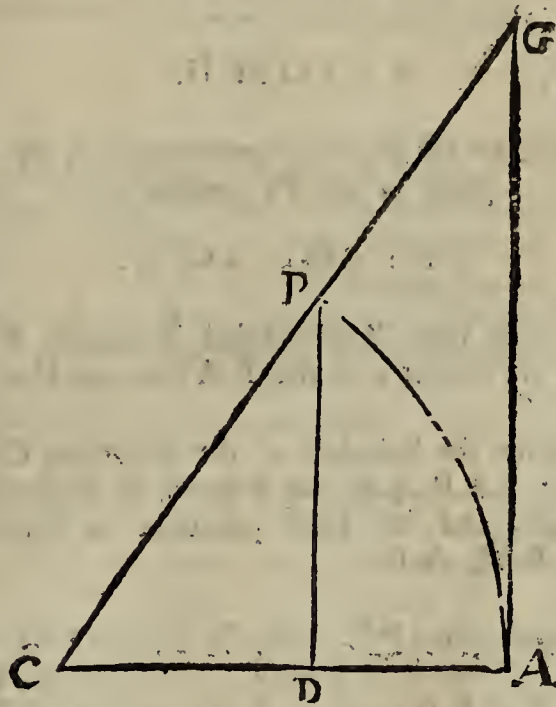


As suppose the two Arks,  $BP$ ,  $BA$ , and that  $BPH$ , the Plane of the greater Ark were turn'd round  $BH$ , till that a Right-Line falling from  $P$  perpendicular to the Plane  $BAH$ , may fall on the same Point of the Line  $CA$ , suppose on  $D$ ; for in that Position  $PAB$  will be a Spherick Triangle Right-angled at  $A$ , and  $BP$  the Hypotenuse,  $BA$  the Base,  $PA$  the perpendicular Arch.

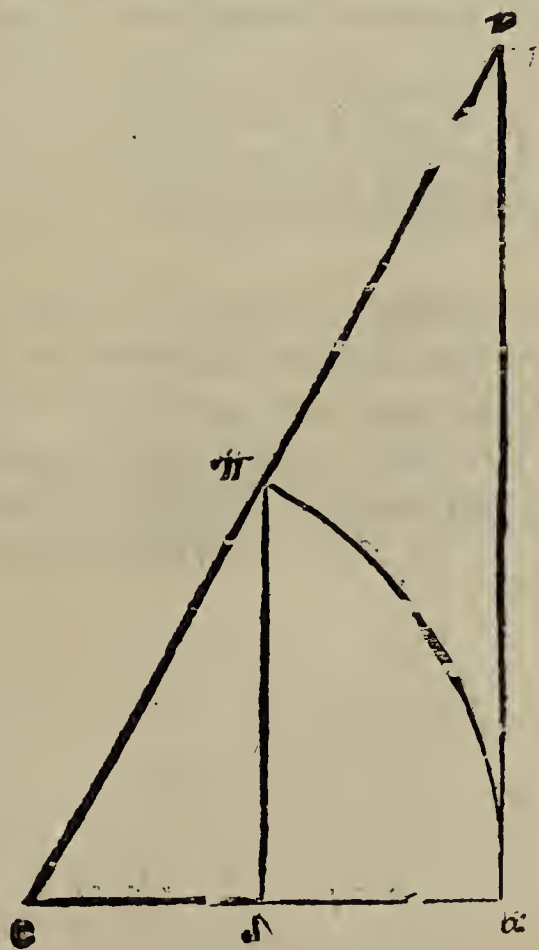
And suppose  $PA$  (in the next Figure) be equal  $PA$  of the Triangle, and fitted according to its Letter therein, and draw  $AE$ ,  $PF$  perpendicular to  $BC$ ; so  $AE$ ,  $PE$ ,  $PD$ , will be Sines of the Arks  $BA$ ,  $BP$ ,  $PA$ , and their Co-sines will be  $EC$ ,  $FC$ ,  $DC$ .

VOL. II.

These things being done and conceived, the two first Axioms of *Spherick Trigonometry* will presently appear, and also the Demonstration of the 16 Cases of Right-angled Triangles, without any other Figure or Production of Sides; as is usual.



To that End, let the Ark  $\pi\alpha$  (Fig. 3.) be also fitted in the Solid, according to its Letters; (as you will find it very well done in Mr. Heynes's *Trigonometry*.) Then in the two Right-angled Spherick Triangles,  $PBA$ ,  $\pi B\alpha$ , having the same Acute Angle  $B$ , at the Base:



8 G

AXIOM



AXIOM I.

*The Sines of the Hypothenuses are proportional to the Sines of the Perpendiculars.*

$$PF : PD :: \pi C : \pi d.$$

AXIOM II.

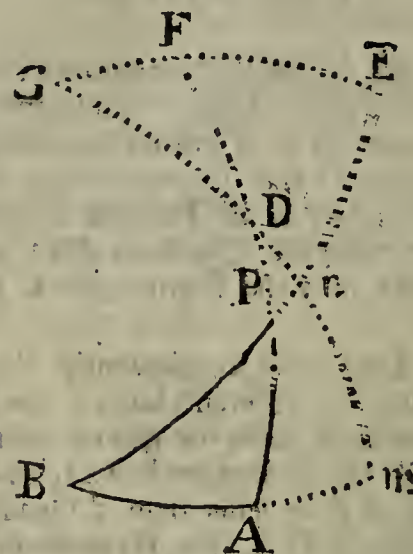
*The Sines of the Bases are proportional to the Tangents of the Perpendiculars.*

$$AE : AG :: a C, a \gamma.$$

For the two Right-angled Triangles FPD,  $C \pi d$ , are similar; as also EAG, and  $C a \gamma$ .

And for the Solution of the following Cases, I suppose BAP (in this Figure) a Right-angled Triangle, and its Sides produced to Quadrants BN, BM, AD.

Suppose also, PE, PF, NG, and EG, Quadrants. Then is NE equal to BP, and the Complement of BA equal to AM, equal to  $b A D M$ , and FE equal to Angle FPE, equal to Angle BPA, and GD equal to NM, equal to Angle B, and the Angles at A, M, N, E, and F, right.



*N. B.* The Reason of producing the Sides of the Triangle BAP to Quadrants, is, because by this means the Angles may be turned into Sides, and the Hypothenuses into Bases and Perpendiculars, & *à contra*: And from hence it comes to pass, that the Parts of the Triangle given, do sometimes fall in Co-sines and Co-Tangents, instead of Sines and Tangents.

Here follow the Proportions for *Right-angled Triangles*.



*The Propositions for the Solution of the Sixteen Cases of Right-angled Spherick Triangles, with their Solutions of the Ambiguities.*

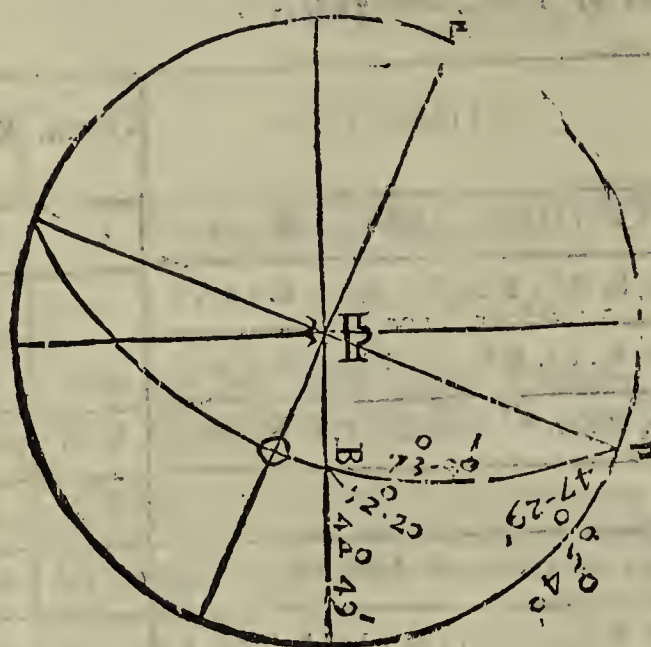
|    | Given. | Req. |   |   |  | Given.   | Req.   |
|----|--------|------|---|---|--|----------|--------|
| 1  | BA, PA | BP   | S, DA:R.S, AM::S, DP:S, PN (by Ax.1.)   | i. e. R:cs:BA::cs, PA:cs, BP. (Sol. 2.)   |  | c c.     | b.     |
| 2  | BA, PA | B    | S, BA:S, BM::T, PA:T, MN (by Ax.2.)     | i. e. S, BA:R::T, PA:T, B. (Sol. 1.)      |  | c c      | L.     |
| 3  | BP, P  | B    | S, PE:S, PN::T, FE:T, DN (by Ax.2.)     | i. e. R:cs, BP::T, P:ct, B. (Sol. 1.)     |  | b L.     | L.     |
| 4  | BP, P  | BA   | S, GE:S, GF::T, EN:T, FD;               | i. e. R:cs, P::T, PB:T, PA (sol. 3.)      |  | b L.     | L adj. |
| 5  | BP, P  | BA   | R:S, BP::S, P::S, BA (by Ax.1.) Sol. 1  |   |  | b L.     | c op.  |
| 6  | PA, P  | BP   | S, GF:s, GE::T, DF:T, NE;               | i. e. cs, P:R::t, PA:t, BP. (sol. 5.)     |  | c L adj. | b.     |
| 7  | PA, P  | B    | S, PF:S, PD::S, FE:S, DN;               | i. e. R:cs, PA::S, P:csB. (Sol. 1.)       |  | c L adj. | L.     |
| 8  | BA, B  | PA   | S, BM:S, BA::T, MN:T, PA;               | i. e. R:S, BA::T, B:TPA. (sol. 1.)        |  | c L adj. | c.     |
| 9  | PA, B  | BA   | T, MN:S, BM::T, PA:S, BA;               | i. e. T, B:R::T, PA:S, BA. (Ax.2.) Ambig. |  | c L op.  | c.     |
| 10 | PA, B  | BP   | S, B:R::S, PA:S, BP (Ax. 1.) Ambiguous. |   |  | c, L op. | b.     |
| 11 | PA, B  | P    | S, PD:S, PF::S, DN:S, FE;               | i. e. cs, PA:R::cs, B:S, P Ambiguous      |  | c L op.  | L.     |
| 12 | PA, BP | P    | T, NE:S, EG::T, FD:S, FG                | i. e. T, BP:R::T, PA:cs, P. (Sol. 3.)     |  | c. b.    | L adj. |
| 13 | PA, BP | B    | S, BP:S, BN::S, PA:S, NM;               | i. e. S, BP:R::S, PA:S, B. (Sol. 1.)      |  | c. b.    | L op.  |
| 14 | PA, BP | BA   | cs, PA:R::cs, BP:cs, BA (Sol. 2.)       |   |  | c. b.    | c.     |
| 15 | B, P   | BP   | T, FE:S, EP::T, DN:S, PN;               | i. e. t, P:R::ct, B:cs, BP.               |  | L L.     | b.     |
| 16 | B, P   | PA   | S, FE:S, FP::S, DN:S, DP;               | i. e. S, P:R::cs, B:cs, PA. (Sol. 1.)     |  | L L.     | c.     |

*N.B.* If you Project the given Triangle, within a primitive Circle, according to the Doctrine of the Sphere, as was shewed under *Spherick Geometry*, all Ambiguities will vanish; and if the Triangle be oblique, the Perpendicular will be drawn also: And this is a very good Way to gain a clear Notion of *Spherical Trigonometry*; which cannot be understood thoroughly, without the Doctrine of the Sphere, and its several Projections be first learn'd.

*Examples*



Examples of the Sixteen Cases of Right-angled Spherical Triangles.



For the Sun's Declination

### CASE I.

Given the Complement of the Sun's Amplitude  $BA$ , and the Latitude  $PA$ . Required the Sun's Distance from the Pole  $PB$ , which is the Complement of his Declination?

$$R : \Sigma BA :: \Sigma PA : \Sigma BP.$$

$$R. = 10.0000000$$

$$\Sigma BA = 9.8508702 = 44^\circ 49'$$

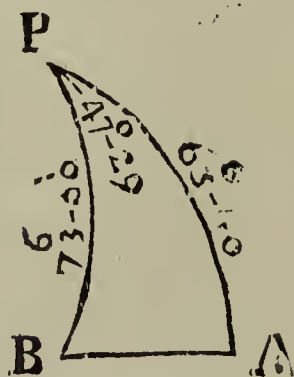
$$\Sigma PA = 9.6149441 = 65^\circ 40'$$

$$\Sigma PB = 9.4658143 = 73^\circ$$

Wherefore the Sun's Declination is 77 Degrees,  $= \odot B$ .

### CASE II.

Given as before  $BA$  and  $PA$ . Required  $B$ , the Angle of the Sun's Position?



$$S, BA : R :: T, PA : T, B.$$

$$S, BA = 9.8480909$$

$$\text{Radius} = 10.$$

$$T, PA = 10.3446523$$

$$T, B = 10.4965614 = 72^\circ 20'$$

### CASE III.

Given  $BP$ , equal to the Sun's Distance from the Pole, and  $P$  the Sun's Hour from Midnight. Required  $B$ , the Angle of the Sun's Position?

$$R : \text{Col. } BP :: T, P : t, B.$$

$$\text{Radius} = 10.$$

$$\Sigma BP = 9.4659353$$

$$T, P = 10.0376939$$

$$t, B = 72^\circ 20' = 9.5036292$$

### CASE IV.

For the Latitude.

Given  $BP$  equal to the Sun's Distance from the Pole, and  $P$  the Hour from Midnight. Required  $PA$  the Latitude?

$$R. \Sigma P :: T, BP : T, PA.$$

$$\text{Radius} = 10.$$

$$\Sigma P = 9.8298212$$

$$T, BP = 10.5146610$$

$$T, PA = 10.3444822 = 65^\circ 40'$$

### CASE V.

For the Sun's Amplitude.

Given as before  $BP$  and  $P$ . Required  $BA$ , equal to the Sun's Amplitude?

$$R : S, BP :: S, P : S, BA.$$

$$\text{Radius} = 10.$$

$$S, BP = 9.9805963$$

$$S, P = 9.8675151$$

$$S, BA = 9.8488114 = \text{Co-Amplitude.}$$

Wherefore, the Sun's Amplitude will be  $45^\circ 11'$ .

### CASE VI.

For the Sun's Declination.

Given  $PA$  equal to the Latitude, and  $P$  the Hour from Midnight. Required  $BP$  equal to the Distance from the Pole, or the Sun's Co-declination?

$$\Sigma B : R :: T, PA : T, BP.$$

$$\Sigma P = 9.8298212$$

$$\text{Radius} = 10.$$

$$T, PA = 10.3446523$$

$$T, BP = 10.5148311 = 83^\circ.$$

CASE



## C A S E VII.

*For the Angle of the Sun's Position.*

Given as before P A, and P. Required B?

$$R. \Sigma P A :: S, P : \Sigma, B.$$

$$R. = 10.$$

$$\Sigma P A = 9.6149441$$

$$S, P = 9.8675151$$

$$\Sigma B = 9.4824592 = 72^\circ 20'$$

## C A S E VIII.

*For the Latitude.*

Given B A equal to the Sun's Amplitude, B equal to the Sun's Position. Required P A the Latitude?

$$R : S, B A :: T, P A.$$

$$\text{Radius} = 10.$$

$$S, B A = 9.8480909$$

$$T, B = 10.4968908$$

$$T, P A = 10.3449817 = 65^\circ 40'$$

## C A S E IX.

Given P A equal to the Latitude, and B the Angle of Position. Required B A equal to the Amplitude?

$$T, B : R :: T, P A : S, B A.$$

$$T, B = 10.4968908$$

$$\text{Radius} = 10.$$

$$T, P A = 10.3446523$$

$$S, B A = 9.8477615 = 40^\circ 49'$$

## C A S E X.

*For the Sun's Distance from the Pole.*

Given P A and B, as before. Required B P, the Sun's Distance from the Pole?

$$S, B : R :: S, P A : S, B P.$$

$$S B = 9.9790192$$

$$\text{Radius} = 10.$$

$$S, P B = 9.9595964$$

$$S, B A = 73^\circ 0' = 9.9805772 = \text{Co-declin.}$$

Wherefore the Declination is 17 Degrees.

V O L. II.

## C A S E XI.

*For the Hour from Midnight.*

Given, as before, P A and B. Required P, the Hour from Midnight?

$$\Sigma P P : R :: \Sigma B : S P.$$

$$\Sigma P A = 9.6149441$$

$$\text{Radius} = 10.$$

$$\Sigma B = 9.4821283$$

$$S, P = 9.8671842 = 47^\circ 29'$$

## C A S E XII.

*For the Hour.*

Given P A, equal to the Latitude B P, equal to the Sun's Amplitude. Required P = Sun's Hour from Midnight?

$$T, B P : R :: T, P A : \Sigma P.$$

$$T, B P = 10.5146610$$

$$\text{Radius} = 10.$$

$$T, P A = 10.3446523$$

$$\Sigma P = 9.8299913 = 47^\circ 21'$$

The Hour from Midnight  $47^\circ 29' = 3 \text{ Hours } 10'.$ 

## C A S E XIII.

*For the Angle of Position.*

Given, as before, P A : P B. Required B, and the Angle of the Sun's Position?

$$S, B P : R :: S, P A : S, B.$$

$$S, B P = 9.9805963$$

$$\text{Radius} = 10.$$

$$S P A = 9.9595964$$

$$S, B = 9.9790001 = 72^\circ 20'$$

## C A S E XIV.

*Given Latitude and Declination. Required the Sun's Amplitude?*

Given, as before, P A and P B. Required B A = Sun's Amplitude?

$$P A : R :: \Sigma B P : \Sigma B A.$$

$$\Sigma P A = 9.6149441$$

$$\text{Radius} = 10.$$

$$\Sigma B P = 9.4659353$$

$$\Sigma B A = 9.8509912 = 44^\circ 49'$$

Equal to the Co-amplitude, wherefore the Sun's Amplitude  $= 45^\circ 11'.$ 

8 H

C A S E



## C A S E X V.

Given B the Angle of the Sun's Position, and P the Hour from Midnight. Required BP the Sun's Distance from the Pole?

$$T, P : R :: t, B : \Sigma B P.$$

$$T, P = 10.0376939$$

$$\text{Radius} = 10.$$

$$t, B = 9.5021092$$

$$t, B P = 9.4654055 = 73^\circ$$

## C A S E X V I.

Given as before B, the Angle of Position, and P the Hour from Midnight. Required PA the Latitude of any Place?

$$S, P : R :: \Sigma B : \Sigma P A.$$

$$S, P = 9.8675151$$

$$\text{Radius} = 10.$$

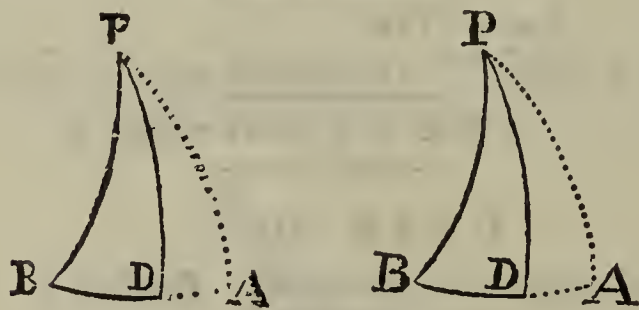
$$\Sigma, B = 9.4821283 = 72^\circ 26'$$

$$\Sigma, P A = 9.6146132 = 24^\circ 19'$$

*Oblique Spherical Triangles* may be reduced to two Right-angled Spherical ones, by letting fall a Perpendicular, which either divides the Oblique Triangle proposed into two Right ones, or makes two Right ones, by adding a Right-angled Triangle to it.

In *Oblique Triangles* there are 12 Cases, 10 of which (by this Preparation) may be solved by the two first Axioms, or by Rules deduced from them.

## R U L E I.



The Co-sines of the Angles at the Base are proportional to the Sines of the Angles at the Vertex. For by *Case 7. of Right-angled Spherick Triangles*,

$$R : cs, P A :: S, B P A : cs, B.$$

$$R : cs, P A :: S, D P A : cs, D.$$

$$\text{Therefore } cs, B : S, B P A :: cs, D : S, D P A.$$

## R U L E II.

The Co-sine of the Sides are proportional to the Co-sines of the Bases. For by *Case 1. of Right-angled Spherick Triangles*,

$$R : cs, P A :: cs, B A : cs, B P.$$

$$R : cs, P A :: cs, C A : cs, D P.$$

$$\text{Therefore, } cs, B A : cs, B P :: cs, D A : cs, D P.$$

## R U L E III.

The Sines of the Bases are reciprocally proportional to the Tangents of the Angles at the Bases. For by *Axiom 2.*

$$S, B A : R :: T, P A : T, B.$$

$$S, D A : R :: T, P A : T, D.$$

$$\text{Therefore } S, B A \times T, B = R \times T, A = S, D A \times T, D.$$

$$\text{Consequently } S, B A : S, D A :: T, D : T, B.$$

## R U L E IV.

The Tangent of the Sides are reciprocally proportional to the Co-sines of the Angles at the Vertex. For by *Case 4.*

$$T, B P : R :: T, P A : cs, D P A.$$

$$T, D P : R :: T, P A : cs, D P A.$$

$$\text{Therefore } T, B P : T, D P :: cs, D P A : cs, B P A.$$

## A X I O M III.

In any Triangle the Sines of the Sides are proportional to the Sines of the opposite Angles. For by *Axiom 1.*

$$S, B P : R :: S, P A : S, B.$$

$$S, D P : R :: S, P A : S, D.$$

$$\text{Therefore } S, B P : S, D P :: S, D : S, B.$$

In letting fall your Perpendicular, observe this Rule.

*Let it fall from the End of a given Side, and opposite to a given Angle.*

For by so doing, you have enough given in one of the Right-angled Triangles to determine any of its unknown Parts.

The two first Cases are solved each by one Operation by the third Axiom; the other eight Cases are solved each by two Operations.

Observe also, the Addition or Subtraction both of the Segments of the Base, and Angles at the Vertex, according as the Perpendicular falls within or without the Triangle.

*Proportions.*



*Proportions for the Solving the first Ten Cases of Oblique Spherick Triangles.*

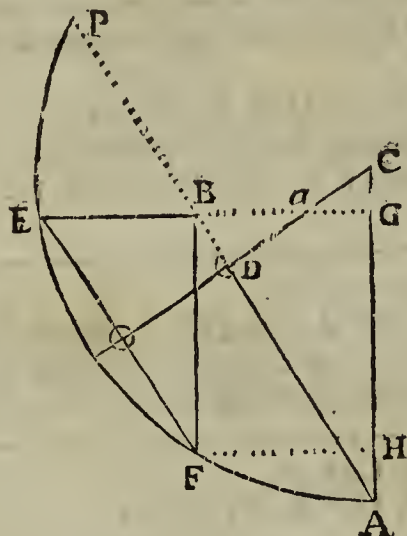
| Cafe. | Given.     | Req. | Proportion.  |
|-------|------------|------|--|
| 1     | BP. PD. B. | D.   | $S, PD : S, B :: S, BP : S, D$ . <i>Ambiguous.</i>   |
| 2     | BP. B. D.  | PD.  | $S, D : S, BP :: S, B : SPD$ . <i>Ambiguous.</i>   |
| 3     | BP. PDB    | BD.  | $R : cs, B :: T, BP : T, BA$ , by <i>Case 4th</i> of Right-angled Spherick Triangles.<br>Then $cs, BP : ts BA :: cs, DP : cs, DA$ , by <i>Rule 2d</i> .<br>Then $BA \pm DA = BD$ , according as the Perpendicular falls within or without the Triangles; which is doubtful, unless the Kind of the Angle D is known.   |
| 4     | BP. PD. B. | P.   | $R : cs, BP :: TB : ct, BPA$ , by <i>Case 3d</i> .<br>And then, $T, DP : T, BP :: cs, BPA : cs, DPA$ , by <i>Rule 4th</i> .<br>Then $BPA \pm DPA = PBD$ . Here also, the falling of P A is doubtful, unless you know the Kind of the Angle D.  |
| 5     | BP, B, D.  | P.   | $cs, BP : R :: ct, B : T, BPA$ , by <i>Case 3d</i> .<br>Then, $cs, B : S, BPA :: cs, D : S, DPA$ , by <i>Rule 1</i> .<br>Then, if B and D are $\begin{cases} \text{alike} \\ \text{unlike} \end{cases}$ $BA \pm DPA = BD$ .  |
| 6     | BP, B, D.  | BD.  | $cs, B : R :: ct, BP : ct, BA$ , by <i>Case 4th</i> .<br>Then $T, D : T, B :: S, BA : S, DA$ , by <i>Rule 3d</i> .<br>And then, if B and D are $\begin{cases} \text{alike} \\ \text{unlike} \end{cases}$ $BPA \pm DA = BPD$ .  |
| 7     | B, P. BP.  | D.   | $cs, BP : R :: ct, B : T, BPA$ , by <i>Case 3d</i> .<br>Then $s, BPA : s, DPA :: cs, D$ , by <i>Rule 1</i> .<br>If $BPA \supset BPD$ , and $B \begin{cases} \text{acute} \\ \text{obtuse} \end{cases}$ , D is $\begin{cases} \text{obtuse} \\ \text{acute} \end{cases}$ .<br>But if $BPA \supset BPD$ , and $B \begin{cases} \text{acute} \\ \text{obtuse} \end{cases}$ , D is $\begin{cases} \text{acute} \\ \text{obtuse} \end{cases}$ . |
| 8     | B, P. BP.  | DP.  | $cs, BP : R :: ct, B : T, BPA$ , by <i>Case 3d</i> .<br>Then $cs, DPA : cs, BPA :: T, BP : DP$ , by <i>Rule 4th</i> .<br>Then, if DPA is $\begin{cases} \text{like to} \\ \text{unlike} \end{cases}$ B, DP is $\begin{cases} \supset \\ \subset \end{cases}$ than a Quadrant.  |
| 9     | BP. BD. B. | DP.  | $cs, B : R :: T, BP : T, BA$ , by <i>Case 4th</i> .<br>Then $cs, BA : cs, BP :: cs, DA : cs, DP$ by <i>Rule 2d</i> .<br>Then, if DA is $\begin{cases} \text{like} \\ \text{unlike} \end{cases}$ (PA) $\supset B$ , BD is $\begin{cases} \supset \\ \subset \end{cases}$ than a Quadrant.   |
| 10    | BP. BD. B. | D.   | $cs, B : R :: T, BP : T, BA$ , by <i>Case 4th</i> .<br>Then $S, DA : S, BA :: T, B : T, D$ , by <i>Rule 3d</i> .<br>Then if BA is $\begin{cases} \supset \\ \subset \end{cases}$ BD, D is $\begin{cases} \text{like} \\ \text{unlike} \end{cases}$ B.  |

LEMMA



LEMMA.

The Difference of the versed Sines of two Arks multiplied by half the Radius, is equal to the Sine of half the Sum of those Arks multiplied by the Sine of half the Difference of the Arks.



Suppose AF, AE, the two Arks; the Difference of the versed Sines is AG — AH = GH = BF, and the Sine of half the Sum of the Arks is AD, for EP = FA, the Sine of half the Difference of the Arks is FO. Now the Triangles ACD, EFB, are Similar (for the Triangles aCG, Eoa are Similar, therefore the Angle C equal to the Angle F); therefore, as AC : AD :: FE : FB, or  $\frac{1}{2} AC : AD :: \frac{1}{2} FE (i. e. FO) : FB$ ; therefore  $\frac{1}{2} AC \times FB = FO \times AD$ . For since AC : AD :: FE : FB; therefore AC × FB = AD × FE; and consequently  $\frac{1}{2} AC \times FB = \frac{1}{2} AD \times FE$ ; that is = AD ×  $\frac{1}{2} EF$  = AD × OF. Q. E. D.

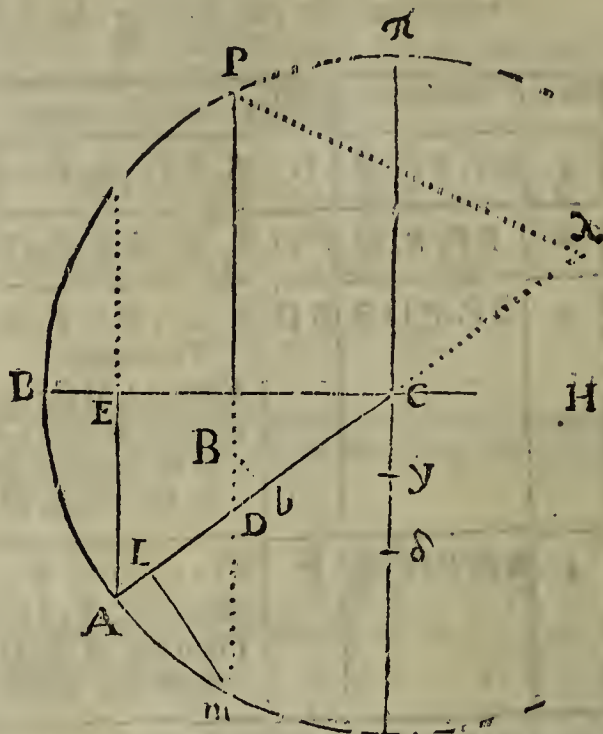
AXIOM IV.

The Rectangle, or Product of the Sines of the Legs, is to the Square of the Radius :: As the Difference of the versed Sines of the Base, and of the Difference of the Legs, to the versed Sine of the vertical Angle.

Demonstration.

Resume the foresaid Circles of Pasteboard, and suppose there B the Angle required, BA, BP (equal BM) its Legs, PA the Base to be any way oblique to the Plane BA, and not perpendicular as before. Then will BPA be an oblique Triangle.

Let fall PB perpendicular to Bm, and  $\pi y$  perpendicular to Ca, and Bb to bA, and mL perpendicular to cA; therefore Bb is perpendicular to cA, and bL equal bA — LA equal to the versed Sine of the Base, less the versed Sine of the Difference of the Legs.



But AE : AC :: bL : Bm.

And mF : ac :: Bm : ya.

Therefore multiplying the Correspondent Terms of both Proportions.

$$AE \times mF : AC \times ac :: bL \times Bm : Bm \times ya.$$

CASE XI.

The Three Sides of any Spherick Triangle being given, to find an Angle?

The Rectangle of the Sines of the Legs, Is to the Square of the Radius :: As the Sine of  $\frac{1}{2}$  Base more  $\frac{1}{2}$  diff. of the Legs multiplied by the Sine of  $\frac{1}{2}$  Base less  $\frac{1}{2}$  diff. of the Legs, Is to the Square of the Sine of  $\frac{1}{2}$  the Angle required.

Demonstration.

AE × mF : Rq :: (by Ax. 4. bL : ya) bL ×  $\frac{1}{2} R$  : yR ×  $\frac{1}{2} R$ ; (i. e. by the foregoing Lemma, and the first in Mr. Caswell's Trigonometry.)

$$AE \times mF : Rq :: S, \frac{1}{2} \text{ Base} \times \frac{1}{2} \text{ diff. } cr \times S, \frac{1}{2} \text{ Base} - \frac{1}{2} \text{ diff. } cr : S q \frac{1}{2} \text{ Angle.}$$

Example in Numbers.

Suppose BP equal 60°. 10', DP equal 46° 42', BD equal 78°. 30' were given, and the Angle P required?

|  |            |
|--|------------|
| $\frac{1}{2}$ the Base is  | 43°. 45'   |
| $\frac{1}{2}$ the Diff. of the Sides is  | 6. 44      |
| $\frac{1}{2}$ the Base + $\frac{1}{2}$ Diff. of the Sides is   | 50. 29     |
| $\frac{1}{2}$ the Base — $\frac{1}{2}$ Diff. of the Sides is   | 37. 01     |
| Rad. Sq.   | 20.0000000 |
| $S, \frac{1}{2} \text{ Base} + \frac{1}{2} \text{ diff. } cr \times S, \frac{1}{2} \text{ Base} - \frac{1}{2} \text{ diff.}$ | 19.6669325 |

Sum 39.6669235  
Subtract the □ of the Sine of the Legs 19.8302534

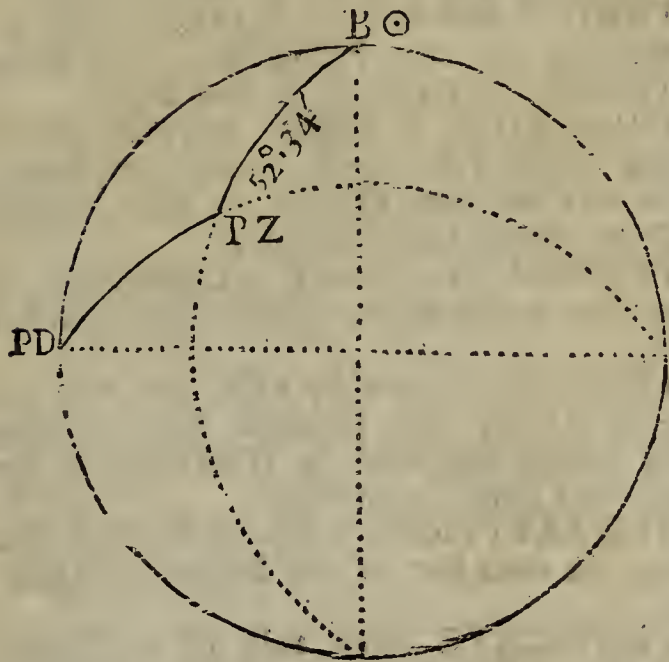
Remainder = Sq. of the Sine of  $\frac{1}{2}$  P 19.8666791  
The  $\frac{1}{2}$  of which is the Sine of 59°. 03' 9.9333393  
That is  $\frac{1}{2}$  the Angle required.

Therefore being doubled is 118°. 06' = P.  
If



If these Data's were projected by the Directions given in *Spherical Geometry*, the Angles may be likewise found, without Calculation, and 'twill stand thus. The Triangle will be  $\odot Z D$ , where

$$\begin{aligned} Z &= P \\ P &= D \\ \odot &= B \\ B D &= \odot P \\ P D &= Z P \\ P B &= Z \odot \end{aligned}$$



### CASE XII.

*The three Angles being given, to find a Side.*

The Angles adjacent to the Side required, call Legs; and the Angle opposite, call Base: Then work as in the 11th Case.

For, such is the Operation in the Supplemental Triangle, whose Angles and Sides are equal to the Supplements of the Sides and Angles of the Triangle proposed: But Arks and their Supplements have the same Sines and Tangents.

*Example in Numbers.*

In the Triangle BDP, there is given the

$$\text{Angle } \begin{cases} P = 143.0, \text{ the Sun's Azimuth from the North} \\ B = 15.04, \text{ the Angle of the Sun's Position:} \\ D = 30.00, \text{ the Hour from Noon.} \end{cases}$$

Required the Side PD, which is the Complement of the Latitude.

$$\begin{aligned} \text{Com. Angle } P &= 37^\circ 00' \} \text{ Ar. co. of } 50.220537 \\ \text{Angle } D &= 30^\circ 00' \} \text{ the Sines. } 90.301030 \\ \text{Angle } B &= 15^\circ 04' = \text{Angle op.} \end{aligned}$$

$$\begin{aligned} \text{Sum} &= 82^\circ 04' \\ \frac{1}{2} \text{ Sum} &= 41^\circ 02' \} \text{ Sines. } 9.817233 \\ \frac{1}{2} \text{ Sum} - \text{Angle op. } 25^\circ 58' & \} 9.641323 \end{aligned}$$

$$\text{The Sum of the 4 Logarithms equal } 19.980113$$

$$\text{Its half is the Co-sine of } 12^\circ 13' \quad 9.990056$$

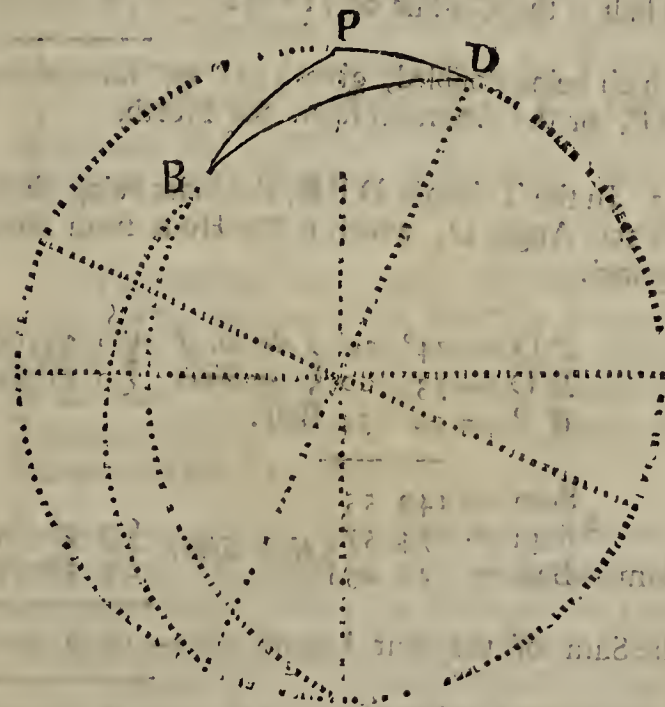
Which doubled, gives  $24^\circ 26'$  equal PD equal Complement of Latitude: Wherefore the Latitude must be  $65^\circ 34'$ .

In a Spherick Triangle, that is Right-angled or Quadrantal, the two Parts which are adjacent to the Right-angle or Quadrant, together with the Complements of the other three, are called; by my Lord Napier, *The Five Circular Parts*. And if the three Parts which enter the Question, (*viz.* 2 given, and 1 required) have no Interruption, (now tho' a Right-angle or Quadrant come between, 'tis not counted an Interruption) that Part which is between the other two, is called *The middle Part*, and then the other two are called *Extreams adjacent*, or *conjunct*. But if there be an Interruption, that Part which is separated from the other two, is called *The middle Part*, and the other two, are *Extreams opposite*, or *disjunct*. This being premised, Napier, after a diligent View of the Solutions of all the Cases of Right-angled and Quadrantal Triangles, has observed, That they all agree in one or two Propositions, *viz.* That the Radius multiplied by the Sine of the middle Part, is equal to the Rectangle or Product made of the Tangents of the Extreams conjunct, or to the Rectangle of the Co-sines of the Extreams disjunct.

This Proposition was invented by the Lord Napier, purely for Ease of Memory, and has been applied in all its Cases by most Authors; as particularly, by Sir Isaac Newton, Norwood, Sir J. Moor, Ward, &c.

*Some more Examples of Oblique Spherick Triangles in Numbers.*

In the Oblique Triangle BPD, (See the Figure following.)



Suppose there be given the Sides.

$$PD = 24^\circ 20', \text{ the Complement of the Sun's Latitude.}$$

$$BD = 73^\circ 00', \text{ the Complement of the Sun's Declination, or his Distance from the North Pole.}$$

$$PB = 52^\circ 34', \text{ the Complement of the Sun's Altitude.}$$

'Tis required to find the Angle.

$$BPD, \text{ the Sun's Azimuth from the North Part of the Meridian.}$$



|  |  |
|--|--|
| $\frac{1}{2}$ the Base is  | 36° 30'  |
| $\frac{1}{2}$ the Diff. of the Side is   | 14 07  |
| $\frac{1}{2}$ the Base $+$ $\frac{1}{2}$ the Diff. of the Sides is   | $\left\{ \begin{array}{l} 50 37 \\ 22 23 \end{array} \right.$      |
| The Radius Square.   | 24 000000  |
| $S; \frac{1}{2}$ Base $+$ $\frac{1}{2}$ Diff. <i>cr.</i> $\times S, \frac{1}{2}$ Base $-$ $\frac{1}{2}$ Diff. <i>cr.</i> | $\left\{ \begin{array}{l} 19.469525 \\ \hline \end{array} \right.$ |

Sum 39 469525

From which Subtr. the  $\square$  of the Sines of the Legs  $\left\{ \begin{array}{l} 19 514701 \\ \hline \end{array} \right.$

Rem. = Sq. of the Sine of  $\frac{1}{2}$  the Angle P. 19 954824  
 Its  $\frac{1}{2}$  is the Sine of  $71^\circ 40' = \frac{1}{2}$  the Angle required  $\left\{ \begin{array}{l} 9 977412 \\ \hline \end{array} \right.$

Therefore being doubled, is  $143^\circ 20' =$  Angle P.

For practical Observations in this Case, nothing is more easy and expeditious than the following Method, of which I shall give two useful Examples: One for the *Azimuth*, as above; the other for the *Hour of the Day*.

In the Triangle DPB, let the same Things be given, and the Angle P, or *Azimuth* required.

|                             |  |   |
|-----------------------------|--|---|
| PD = $24^\circ 20'$         | $\left\{ \begin{array}{l} \text{Ar. co. of the} \\ \text{Sines} \end{array} \right.$ | $\left\{ \begin{array}{l} 50 385056 \\ 20 103146 \end{array} \right.$ |
| BP = $52^\circ 04'$         |  |   |
| BD = $73^\circ 00' =$ Base. |  |   |

Sum = 149 54.

Sum =  $74^\circ 57'$   $\left\{ \begin{array}{l} \text{their Sines} \end{array} \right.$   $\left\{ \begin{array}{l} 8 984842 \\ 9 531822 \end{array} \right.$   
 $\frac{1}{2}$  S — Base =  $1^\circ 57'$

Sum = 19 001872

Its half is the Co-sine of  $71^\circ 32'$  9 500936Which being doubled, gives  $143^\circ 04'$  for the Angle P, or the *Azimuth* from the North.

2. In the Triangle DPB, the Sides being given, and the Angle D, which is the *Hour* from Noon required.

|                           |  |   |
|---------------------------|--|---|
| PD = $24^\circ 20'$       | $\left\{ \begin{array}{l} \text{Ar. co. of} \\ \text{the Sines} \end{array} \right.$ | $\left\{ \begin{array}{l} 50 385056 \\ 20 019404 \end{array} \right.$ |
| BD = $73^\circ 00'$       |  |   |
| BP = $52^\circ 34'$ Base. |  |   |

Sum = 149 55

$\frac{1}{2}$  Sum =  $74^\circ 57'$   $\left\{ \begin{array}{l} \text{their Sines} \end{array} \right.$   $\left\{ \begin{array}{l} 9 984842 \\ 9 580698 \end{array} \right.$   
 $\frac{1}{2}$  Sum — Base =  $22^\circ 23'$

The Sum of the four Logarithms = 19 970000

Its half is the Co-sine of  $14^\circ 58'$  9 985000Which doubled, is  $29^\circ 56' =$  Angle D; and being reduced into Time, gives 1 Hour and above 59 Minutes from Noon, which was required.

TRILATERAL, in Geometry, is the same with a three-sided Figure.

TRIM, of a Ship, is her best Posture, Proportion of Ballast, and hanging of her Masts, &c. for sailing; and therefore, to find the best Way of making any Ship to sail swiftly, is called finding her *Trim*. And this depends very much on Experience and Judgment, and several Trial and Observations which the Commander may make Aboard.

TRINE, is an Aspect of the Planets, when at the Distance of 120 Degrees of 4 Signs from each other, and noted thus  $\Delta$ .

TRINE, *Dimension*, a three-fold Dimension, includes Length, Breadth and Thickness.

TRINGLE, in *Architecture*, is a little Member fixed exactly upon every *Triglyph*, under the Plat-band of the Architrave, from whence hang down the *Guttae* or Pendant-drops in the *Doric* Order.

TRINOMIAL-Root, in *Mathematicks*, is a Root consisting of three Parts connected together by the Sign  $+$ ; as  $a + b + c$ . See *Binomial*.

TRIO, in *Musick*, a Part of a Concert, where in there are only three Persons sing; or a musical Composition, consisting of three Parts.

TRIOCTILE, in *Astrology*, an Aspect or Situation of two Planets with respect to the Earth, when they are three Octaves, or eight Parts of a Circle different from each other.

TRIONES, in *Astronomy*, a Constellation of seven Stars in *Urfa minor*, vulgarly called *Charles's Wane*.

TRIP: The Seamen say a Ship goes with her *Top-sails a-Trip*, when she carries them hoisted up to the highest, and when the Wind blows not too hard, but a gentle, or *Loom-gale*.

TRIPARTITION, is Division by three, or a taking the third Part of any Number or Quantity.

TRIPPLICATE Ratio, must be well distinguished from *Triple*, and is the Ratio of Cubes one to another.

Thus in these Geometrical Proportions 2, 4, 8, 16, 32, as the Ratio of the first Term (2) is to the third (8) Duplicate of the First to the Second, or as 4 the Square of 2, to 16 the Square of 4; so the Ratio of 2 to 16 the fourth Term, is *TriPLICATE*; or as 8 which is the Cube of 2 to 64 the Cube of 4. And this *TriPLICATE Ratio* is compounded of all the preceding Ratio's.

TRIPLICATIO, in the *Civil Law*, is the same as Surjoinder in the Common-Law.

TRIPLICITY, in *Astrology*, is the Division of the Signs according to the Number of Elements; each Division consisting of three Signs.

TRIPLOIDES [of  $\tau\rho\iota\pi\lambda\omicron\varsigma$ , Gr.] a Surgeon's Instrument, with a three-fold Basis, used in restoring great Depressions of the Skull.

TRIPHTHONGUE, a Concourse of Vowels in one Syllable, as *u, a, e*.

TRIPPING; a Term in *Heraldry*: See *Pas-sant*.

TRIPTOTES [ $\tau\rho\iota\pi\tau\omicron\tau\omicron\varsigma$ , Gr.] in *Grammar*, are such defective Nouns as have but three Cases, as *Sordem, Sordis, Sorde* and *Tantundem*, &c.

TRIS-DIAPASON, or *Triple-Diapason*, a Chord in *Musick*, otherwise called a *Triple*, Eighth, or Fifteenth.

TRISE; the Sea Word for haling up any thing by a dead Rope, or one that doth not run in a Block, but 'tis done by Hand or by main Strength: Thus if any Cask, Chest, or other Goods hath only a Rope fastned to it, and so without a Tackle is pulled up into the Ship by Hand, they say it is *Trised up*.

TRISECTION, the Division of a Thing into three.

TRISMUS [of  $\tau\rho\iota\zeta\omega$ , Gr. to gnash the Teeth] is the grinding of the Teeth, or a Convulsion of the Muscles



Muscles of the Temples, whereby the Teeth gnash whether one will or no. *Blanchard.*

TRISOS [of τριζω, Gr.] a Convulsion of the Muscles of the Temples, causing the Teeth to nash.

TRISPAST [τριστασον, Gr.] a Machine, that has three Pulleys.

TRISYLLABLE, [τρισυλλαβη, Gr.] is a Word consisting of but three Syllables.

TRITE, in *Musick*, the third Musical Concord.

TRITÆOPHYES, [of τριταιω, Gr.] is an Ague that comes every third Day. *Blanchard.*

TRITÆUS, is the same with *Febris Tertianæ intermittens.* *Blanchard.*

TRITONE [τριτονη, Gr.] a Term in *Musick*, which signifies a greater Fourth.

TRITURATION, is a pounding in a Mortar, &c. whereby Medicines are reduced to Powder, that they may be the better mixed.

TRITURATION, in *Physick*, is used for the Action of the Stomach on Food.

TROCHANTER, the same that *Rotator.*

TROCHILE [τροχιλη, Gr.] in *Architecture*, is that hollow Ring or Cavity which runs round a Column next to the *Tore*; vulgarly 'tis called the *Casement*: 'Tis frequently bordered or rather shut in with *Lists*. 'Tis often called *Scotia*, from its shady dark Appearance.

TROCHISCI [τροχισκοι, Gr.] *Trochisks*, are round or other figured Medicinal things, made of Powders, mixed with viscous Extracts, and made up into round, triangular, &c. little Bodies, which are to be dried up in the Shade. They are much the same with Tablets and Lozenges.

TROCHITÆ, in *Natural History*, a kind of figured Fossil-Stones resembling Plants, vulgarly called *Cutbert's Beard*; they are usually of an opaque, dark, colour, break like Flint, polished and shining, and are easily dissolved in Vinegar: they are generally of a Cylindrical Form.

TROCHLEA, a Term in *Anatomy*, the same with *Bathmiz.*

TROCHLEA, is also one of the Mechanick Powers, and is what we usually call the *Pulley.*

TROCHLEARIS, is the upper or greater oblique Muscle of the Eye: See *Obliquus Superior.*

TROCHOID [of τροχος, Gr. a top] the same with *Cycloid*; which see.

TROCHOLICKS [of τροχος, Gr.] is by some taken for that Part of the Mechanicks which shews the Properties of all circular Motions.

TROMA [τραυμα, Gr.] is a Wound from an external Cause.

TROMBOSIS [of τρομος, Gr.] is a Trembling, or a Depravation of the voluntary Motion of the Members. *Blanchard.*

TRONATOR of the City of London, an Officer, whose Office is to weigh the Wool brought into the City.



TRONCONNEE, in *Heraldry*, signifies a Cross, or some other thing cut in Pieces; yet so, that all the Pieces are so placed, as to keep up the Form, though set at a small Distance one from the other, as a Cross *Tronconnee*. See the Figure.

TROPES [τροπος, of τρεπω, Gr. to turn,] are when Words are changed from their proper Signi-

fication, and applied to other things than what they naturally mean.

TROPICAL Year: See *Year.*

TROPHY, in *Architecture*, is an Ornament which represents the Trunk of a Tree charged or encompassed all round about with Arms or Military Weapons, both *Offensive* and *Defensive.*

TROPICKS [τροπικαι, of τρεπω, Gr. to turn,] are Circles supposed to be drawn parallel to the *Equinoctial* at 23° 30' Distance from it, one towards the North, called the *Tropick of Cancer*; and the other towards the South, called the *Tropick of Capricorn*, because they lie under these Signs.

Mr. *Halley*, in *Philos. Transf.* N°. 215. by three subsequent Observations made near the Tropick at proper Intervals of Time, shews a Method to find the Moment of the Sun's Ingress into the Tropical Signs, capable of all the Exactness the most Accurate can desire; and that without any Consideration of the Parallax of the Sum of the Refractions of the Air, of the greatest Obliquity of the *Ecliptick*, or Latitude of the Place, premising the following *Lemmata*, viz.

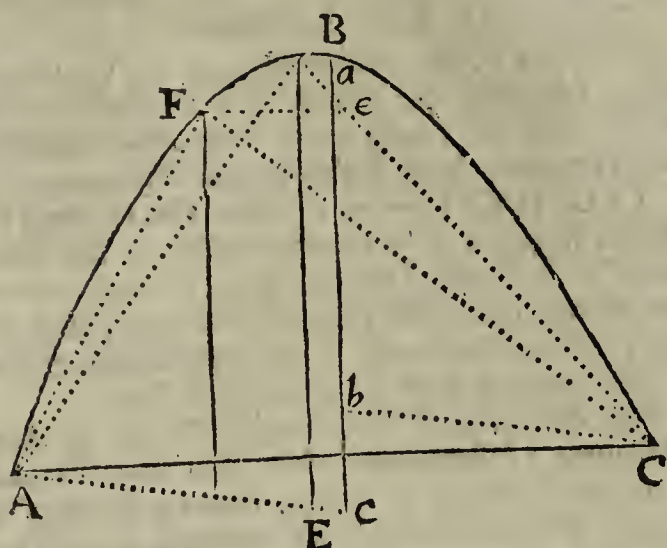
1. That the Motion of the Sun in the *Ecliptick*, about the Time of the Tropicks, is so nearly equable, that the Difference from Equality is not sensible, from five Days before the Tropicks, to five Days after; and the Difference arising from the little Inequality that there is, never amounts to above  $\frac{1}{4}$  of a single Second in the Declination, and this by reason of the Nearness of the *Apogæon* of the Sun to the *Tropick of Cancer.*

2. That for five Degrees before and after the Tropicks, the Differences whereby the Sun falls short of the Tropicks, are as the versed Sines of the Sun's Distance in Longitude from the Tropicks; which versed Sines in Arches under five Degrees, are beyond the utmost Nicety of Sense, as the Squares of those Arches. From these two follows,

3. That for five Days before and after the Tropicks, the Declination of the Sun falls short of the utmost Tropical Declination, by Spaces which are in duplicate Proportion, or as the Squares of the Times by which the Sun is wanting of or past the Moment of the Tropick.

Hence 'tis evident, that if the Shadows of the Sun, either in the Meridian, or any other Azimuth, be carefully observed about the Time of the Tropick, the Spaces whereby the Tropical Shade falls short of, or exceeds those at other Times, are always proportionable to the Squares of the Intervals of Time between those Observations and the true Time of the Tropick; and consequently, if the Line, on which the Limits of the Shade is taken, be made the Axis, and the correspondent Times from the Tropick, expounded by Lines, be erected on their respective Points in the Axis as Ordinates, the Extremities of those Lines shall touch the Curve of a Parabola, as in the following Figure, where *a, b, c, e*, being supposed Points observed, the Lines *aB, bC, cA, eF*, are respectively proportional to the Times of each Observation, before or after the Tropical Moment in *Cancer.*





This being premised, the true Time of the Tropick by three Observations, is found from this Geometrical Problem.

Having three Points in a Parabola,  $A, B, C$ , or  $A, F, C$ , given, together with the Direction of the Axis, to find the Distance of those Points from the Axis.

Of this there are two Cases; the one when the Time of the second Observation  $B$  is precisely in the Middle-time between  $A$  and  $C$ : In this Case, putting  $t$  for the whole Time between  $A$  and  $C$ , then  $Ae$  the Interval of the remotest Observation  $A$  from the Tropick is found by the following Analogy:

$$2ac - bc : 2ac - \frac{1}{2}bc :: \frac{1}{2}t \text{ (or } AE) : Ae,$$

the Time of the remotest Observation  $A$  from the Tropick.

But the other Case, when the middle Observation is not exactly in the Middle between the other two Times, as at  $F$ , is something more operose, and the whole Time from  $A$  to  $C$  being put  $= t$ , and from  $A$  to  $F = S$ ,  $ce = c$ , and  $bc = b$ , the

Theorem will stand thus  $\frac{ttc - bSS}{2tc - 2bS} = Ae$ , the Time sought.

To illustrate this Method of Calculation, he gives the two following Examples.

Anno 1500, Bernard Walther, in the Month of June, at Nuremberg, observed the Chord of the Distance of the Sun from the Zenith, by a large Parallactick Instrument of Ptolemy, as follows.

$$\text{June } \left\{ \begin{array}{l} 2. 45467 \\ 9. 44934 \\ 16. 44990 \end{array} \right\} \text{ and June } \left\{ \begin{array}{l} 8. 44975 \\ 12. 44883 \\ 16. 44990 \end{array} \right\}$$

In both which Cases, the middle Time is exactly in the Middle between the Extreams, and therefore in the former three  $ac = 533$ ,  $bc = 477$  and  $t$ , the Time between being 14 Days; by the first Rule, the Time of the Tropick will be found by this Proportion.

As  $589 : 827 \frac{1}{2} :: \frac{1}{2}t$  (or 7 Days) : 9 d. 2 h. 2'. Whence the Tropick Anno 1500, is concluded to have fallen June 11 d. 20 h. 2'.

In the latter three,  $ae$  equal 107,  $bc$  equal 15, and the whole Interval of Time is 8 Days equal  $t$ ; whence,

As  $199 : 206 \frac{1}{2} :: 4 \text{ Days} : 4 \text{ d. } 3 \text{ h. } 37'$ , which taken from the 16 Day at Noon, leaves 11 d. 20 h. 33' for the Time of the Tropick agreeing with the former to the third Part of an Hour.

Anno 1636, Gassendus at Marseilles observed the Summer Solstice by a Gnomon of 55 Foot high, in order to determine the Proportion of the Gnomon to the Solstitial Shade; and he left these Observations; serving for the second Rule.

$$\begin{array}{l} \text{June 19} \\ \text{June 20} \\ \text{June 21} \\ \text{June 21} \end{array} \left\{ \begin{array}{l} \text{Shadow} \\ \text{Sh. N.} \end{array} \right\} \left\{ \begin{array}{l} 31766 \\ 31753 \\ 31751 \\ 31759 \end{array} \right\} \text{ Parts whereof the Gnomon was } 89428.$$

These being divided into two Sets of three Observations each, viz: the 19th, 20th, and 22d; and the 19, 21st, and 22d, there will be in the first three,  $c$  equal 13,  $b$  equal 7,  $t$  equal 3 Days,  $S$  equal 1; and in the second,  $c$  equal 15,  $b$  equal 7,  $t$  equal 3, and  $S$  equal 2. Whence, according to the Rule, the 19th Day at Noon, the Sun wanted of the Tropick a Time proportionate to one Day, as  $ttc - SSb$  to  $2tc - 2bS$ ; that is, as 110 to 64 in the first Set, or 170 to 62 in the second Set; that is 1 d. 17 h. 15' in the first, or 1 d. 17 h. 25', in the second Set; whence it may be concluded, that the Moment of the Tropick was on June 10 d. 17 h. 20' in the Meridian of Marseilles.

The great Advantage of this Method is, that any very high Building serves for an Instrument, or the Top of a high Tower or Steeple, or even any high Wall whatsoever, that may be sufficient to intercept the Sun, and cast a true Shade. Nor is the Position of the Plane on which you take the Shade, or that of the Line thereon, on which you measure the Recess of the Sun from the Tropick, very material; but in what way soever you discover it, the said Recess will be always in the same Proportion, by reason of the smallness of the Angle, which is not 6 Minutes in the first five Days: Nor need you enquire the Height or Distance of your Building, provided it be very great, so as to make the Spaces you measure, large and fair. But it is convenient, that the Plane on which you take the Shade, be not far from perpendicular to the Sun, at least not very oblique; and that the Wall which casts the Shade, be streight and smooth at top, and its Direction nearly East and West. And it will be requisite to take the Extream greatest or least Deviation of the Shadow of the Wall, because the Shade continues for a good time at a stand without Alteration, which will give the Observer leisure to be assured of what he does, and not be surprized by the quick transient Motion of the Shade of a single Point at such a Distance.

The principal Objection is, that the Penumbra or Partile Shade of the Sun, is in its Extreams very difficult to distinguish from the true Shade, which will render this Observation hard to determine nicely.

But if the Sun be transmitted through a Telescope, after the manner used to take his Species in a Solar Eclipse, and the upper half of the Object-glass be cut off by a Paper pasted thereon, and the exact upper Limb of the Sun be seen just emerging out of, or rather continging the Species of the Wall (the Position of the Telescope being regulated by a fine Hair extended in the Focus of the Eye-glass) then by this Means the Limit of the Shade may be obtained to the utmost Exactness.

TROVER,



**TROVER**, in Law, is an Action which a Man hath against one, that having found any of his Goods, refuses to deliver them upon Demand. Of late, Actions of Detinue are much turn'd into Actions upon the Case, *Sur Trover & Conversion*.

**TROUGH** of the Sea, is the Hollow or Cavity made between any two Waves or Billows in a rowling Sea; and when a Ship lies down there, they say, *She lies in the Trough of the Sea*.

**TRUCKS**, belonging to the Carriage of a Piece of Ordnance, are the Wheels which are on the Axletree to move the Piece.

**TRUE Conjunction**. See *Conjunction True*.

**TRUE Place** of a Planet or Star, is a Point of the Heavens shewn by a right Line drawn from the Centre of the Earth through the Centre of the Planet or Star; whereas its *apparent Place*, is that which is found by a right Line drawn from the Observer's Eye through the Centre of the Planet or Star: And this Point in the Heavens is referr'd to the Ecliptick or Zodiack, by the Planet or Star's Circle of Longitude.

**TRULLIZATION**, in ancient Architecture, a Term that Vitruvius uses for all sorts of Arches or Layers wrought with the Trowel in the Inside of Vaults, or for Hatches made on the Layer of Mortar, to retain the Lining of Stuc.

**TRUNCATED Pyramid** or *Cone*, is one whose Top is cut off by a Plane parallel to its Base; and therefore the Figure of the truncated Top must always be similar to the Base.

How to find its *Solidity*, see in the Word *Frustrum*.

A Truncated Cone, or the *Frustrum* of that Body, is called sometimes a *Curti-Cone*.

**TRUNK**, in Anatomy, the Busto of a Human Body, exclusive of the Head and Limbs; also the Body of an Artery or Vein, in Contradistinction to the Branches or Ramification of it.

**TRUNK**, in Architecture, the Fust or Shaft of a Column; with that Part of the Pedestal between the Base and the Cornice, called the *Dye*.

**TRUNK Roots** of a Plant, are little Roots which break or grow out of the Trunks of Plants; and are of two Kinds.

1<sup>st</sup>, Such as Vegetate by a direct Descent, the Place of their Eruption being sometimes all along the Trunks, as in *Mints*, &c. and sometimes only in the utmost Point, as in *Brambles*.

2<sup>dly</sup>, Such as neither ascend nor descend, but shoot forth at Right Angles with the Trunk; which therefore, tho' as to their Office they are true Roots, yet as to their Nature they are a middle thing between a Trunk and a Root. Dr. Grew *Anat. of Plants*, p. 27.

**TRUNKED**, in Heraldry, is applied to Trees cut off at one End, the same as *truncated*.

**TRUNNIONS** of a Piece of Ordnance, are those Knobs or Bunches of the Gun's Metal which bear her upon the Cheeks of the Carriages.

**TRUSS** of Flowers, in Botany, many Flowers growing together on the Head of a Stalk, as in *Auricula's*, &c.

**TRUSSES**, are Ropes fastned to the Parrels of a Yard in a Ship, serving either to bind fast the Yards to the Masts, when the Ship rowls, lying either a *Hull*, or at Anchor; or to hale down the Yards in a Storm, or Gust of Wind: They belong

to the Main-yard, Fore-yard, and Mizen, and are all brought to upon occasion.

**TRUTINA** *Hermittis*, in Astrology; an artificial Method of examining and rectifying a Nativity.

**TRY**; a Ship is said to *Try*, when she hath no more Sails abroad but her Main-sail: When her *Tacks* are close aboard, the *Bowlings* set up, and the *Sheats* haled close aft; when also the Helm is tied close down to the Board, and so she is let lie in the Sea. And sometimes when it blows so hard, that they cannot maintain the Main-sail, as they say; that is, cannot bear it out; they make her lie a *Try* under a *Mizen-sail* only.

**TUBA-Eustachiana**, is the Canal of Communication between the Mouth and the Barrel of the Ear; 'tis so called by *Antonius Valsalva* from its Figure, and its first Discoverer, *Barthol. Eustachius*.

**TUBÆ Fallopiæ**, are two slender Passages, proceeding from the Womb, which when they are a little removed from it, grow gradually wider: They have large Holes or Orifices, which almost lie shut, the extream Edges falling flat; yet if they be diligently opened and dilated, they represent the extream Orifice of a Trumpet. Their Use is to receive the Eggs from the Testicles, and carry them into the Womb, according to the Excellent *R. de Graef*; the Truth whereof is evident from the Inspection of Rabbits dissected.

**TUBER**, properly, is a subterraneous Mushroom, or a *Truffle*; but by Botanick Writers is often used to signify the round turgid Roots of some Plants: Which therefore they call *Tuberose Roots*, or *Knobby Roots*, as Mr. Ray Englishes it.

**TUBEROSITY**, in Physick, a Knot or Tumour growing naturally in any Part in Opposition to Tumours which arise accidentally, or from a Disease.

**TUBERCLES**, in Anatomy, is a Name used by some Writers for those small Tubes through which the Milk flows in the Nipple of the Breast.

**TUBEROUS**: See *Tuber*.

**TUBULI Lactiferi**, certain Lactiferous, or Milk-carrying Pipes, which are as it were the Storehouse wherein the Milk is kept, and through which, as by Conduits, it flows to the Nipples of the Breasts of Females when they give Suck.

**TUBULI Vermiculares**, are certain small winding Cavities formed on the outsides of the Shells of Marine Shell-Fishes, in which some small Worms inhabit and breed.

These are very frequently found on such *Fossil Shells* as are dug up almost every where out of the Earth; and therefore help to demonstrate that they are real Shells, and not *formed Stones*, as some will have it.

**TUCK** of a Ship, is the trussing or gathering up of her Quarter under Water; which if she lie deep, makes her have a broad, or, as they call it, *Fat Quarter*, and hinders her Steering, by keeping the Water from passing swiftly to her Rudder; and if this Trussing lie too high above the Water, she will want bearing for her Works behind, unless her Quarter be very well laid out.

**TUMOR**; by this Word, which in general signifies any Swelling, the Chirurgeons understand a *Disease*, or morbid Affection, incident most usually to the Organical Parts of the Body, increasing their Quantity preternaturally by Means



of some superfluous Humours coming thither from other Parts.

**TUMBREL**, *Tumbrellum*, *Turbicketum*, is an Engine of Punishment, which ought to be in every Liberty that hath View of Frank-Pledge for the Correction of Scolds and unquiet Women; and was what we now call a *Cucking-stool*.

**TUNICA Vaginalis**, is the first of the proper Integuments of the *Testes*; 'tis formed by the Dilation of the Productions of the external Membrane of the *Peritonæum*. Its internal Superficies is smooth, its external rough: It contains the *Vasa Deferentia* and *Præparantia*; it embraces loosely the whole Body of the Testicle, adhering to one end of the *Epydidimis*; and on the out-side of it runs the Muscle called *Cremaster*, which see.

**TUNICLE**, in Anatomy, signifies a Membranous Coat.

**TUNNAGE**: See *Tonnage*.

**TURBINATED**, in *Natural History*, a Term apply'd to Shells and other Bodies that are of a conical Figure, and represent a Peer or Top.

**TURBITH Mineral**, or Yellow Precipitate of Mercury, is thus made. Put any Quantity of good Quicksilver into a Glass Retort, and pour on it four times its Weight of Oil of Vitriol. Set the Retort in Sand, and when the Mercury is dissolv'd, which 'twill hardly be in ten Hours time, distil off the Humidity gently at first, but make a strong Fire at last to drive out all the Spirits. When you break the Retort, you will find in it a white Mass, which Powder in a Glass Mortar; and then pouring warm Water upon it, it will presently turn *Yellow*; it must be washed several times and dried in the Shade, and then 'twill Vomit and Purge strongly.

**TURIONES**, amongst Botanick Writers, are the first young tender Shoots or Tops which any Plants do annually put forth of the Ground.

**TURN**, a Term belonging to the Movement of a Watch, and signifies the entire Revolution of any Wheel or Pinion.

The Number of *Turns* which the *Pinion* hath in one *Turn* of the *Wheel*, is commonly set down as a *Quotient* in common Arithmetick, thus, 5) 60 (12 where the *Pinion* 5 playing in a *Wheel* of 60, moveth round 12 times in one *Turn* of the *Wheel*.

Now, by knowing the Number of *Turns* which any *Pinion* hath in one *Turn* of the *Wheel* it worketh in, you may also find how many *Turns* a *Wheel* or *Pinion* hath at a greater Distance; as the *Contrate-wheel*, *Crown-wheel*, &c.

For, 'tis but multiplying together the *Quotients* and the Number produced, is the Number of *Turns*, as in this Example:

$$\begin{array}{r} 5) 55 (11 \\ 5) 45 ( 9 \\ 5) 50 ( 8 \end{array}$$

The first of these three Numbers hath 11 *Turns*, the next 9, and the last 8. If you multiply 11 by 9, it produceth 99; that is, in one *Turn* of the *Wheel* 55, there are 99 *Turns* of the second *Pinion* 5, or the *Wheel* 40, which runs concentrical, or on the same *Arbor* with the second *Pinion* 5. If you multiply 99 by the last Quotient 8, it produces 792, which is the Number of *Turns* the third *Pinion* 5 hath.

**TURN**, is the Sheriff's Court, kept twice every Year, *viz.* within a Month after *Easter*, and within a Month after *Michaelmas*, *Magna Charta*, cap. 35. From this Court are exempted only Archbishops, Bishops, Earls, Barons, all religious Men and Women, and all such as have Hundreds of their own to be kept. It is a Court of Record in all Things that pertain to it: It is also the King's Leet through all the Country, and the Sheriff is Judge: and this Court is incident to his Office.

**TURN-Pikes**, in the Art of War, are Spars of Wood of 12 or 14 Foot long, and about 6 Inches Diameter in a sexangular Form: They are bored with Holes, one right under another, about an Inch Diameter; the Axis of each Hole must be six Inches one from another; but to go by Turns from each side, the Pickets that are driven into the Hole are 6 or 5 Foot long, pointed with Iron, and with Wedges or Nails fasten'd hard into the Holes.

Two of these fasten'd together with an Iron Chain and Staple, some 6 Inches long, will be of great Use to stop the Enemies in the Breaches or elsewhere. But those that are intended to be thrown in Breaches, must be made of Oak, and need not be so big, or the Pickets so long.

**TURN** *Vicecomitum*, is a Writ that lies for those that are called to the Sheriff's *Turn* out of their own Hundred.

**TUSCAN Order** of Architecture; so called, because invented in *Tuscany*, an eminent Part of *Italy*. 'Tis the most plain of all the 5, and is seldom us'd but in some Country Building, where there is no need of any *Order* but one; or else in some very great Building, such as an *Amphitheatre*, or the like, where all the Orders are design'd to be used.

The Columns here, together with Base and Capital, are to be 7 Modules in Length, and to have their Thickness diminish'd by Degrees to a quarter Part. When these Columns stand alone, the Spaces between them, or the *Inter-Columns*, ought to be very large.

Their *Pedestals* ought to be one Module high; and the *Base* of the *Column* ought to be of the Height of half its Thickness; and that Height divided into two equal Parts, makes the *Orle* or *Plinth*, which is made with a kind of Compass; the other is divided into 4 Parts, of which, one is for the *List*, the other for the *Tore*, or thick round Circle of the Pillar.

The *Base* hath a *Saille* or bearing out, which is the 16th Part of the Diameter of the Column.

The *Capital* is an Height half the Thickness of the Column at the *Base*; and is divided into three equal Parts (according to *Ozanam*) of which, one is for the *Abacus*, the other for the *Oeuf*, as they call it in *French*, *i. e.* the *Ornament*; and the third Part being divided into 7 Divisions, the first makes the *List* under the *Ornament*; and the other six serve for the *Gorgerin Collier* or *Frise*. The *Astragal* is the Height of the *List* below the *Ornament*.

**TURUNDA**, in *Surgery*, a Tent or any Thing to be thrust into an Orifice or Cavity.

**TUSCAN Work**, in Architecture, is the most simple and rude of the Five ancient Orders of Pillars: See *Column* and *Order*.

**TUT**, in *Armoury*, an Imperial Ensign of a golden Globe with a Cross on it.



TWIGILD : See *Angild*.

TWILIGHT, is that dubious Half-light which we perceive before the Sun-rising, and after Sun-setting. 'Tis occasion'd by the Earth's Atmosphere and the Splendor of the Æther which environs the Sun. The Ethereal accended Atmosphere of the Sun, not setting so soon as, and rising before the Sun ; and the Sun's Rays also illuminating the Earth's Atmosphere, before the Body of the Sun itself can appear, occasions a Light always preceding at the Rise, and subsequent to the Setting of that Planet. Which, tho' because of many accidental Variations in both the Sun's and Earth's Atmosphere, it cannot be always of the same Degree of Duration or Brightness ; yet it usually holds in the Evenings, 'till the Sun is about 18 Degrees below the Horizon, and appears so long before his Rise in the Morning : And therefore will be least under the Equator, where the Sun rises and sets at Right-angles to the Horizon ; and so will increase more and more, according as the Position of the Sphere grows more oblique : For, in our Latitude, for a good Part of the Year, the Sun is never above 18 Degrees below the Earth ; and consequently, all that Time we have no Night, but continual Twilight.

TYCHONIAN System or Hypothesis, is so called, from having been advanced to solve the *Phænomena* of Astronomy, by the noble *Tycho Brahe*. He supposes the Earth fixed and immovable in the Centre of the Universe, or of the Sphere of the fixed Stars ; so that all the Stars and Planets are supposed to revolve round the Earth in the space of twenty-four Hours. The Moon also he supposes to move round the Earth, as the Centre of her menstrual Motion : But the five other Planets, *Saturn, Jupiter, Mars, Venus* and *Mercury*, he supposes to revolve round the Sun in their several Periods, as the Sun doth round the Earth in a Year's time. But this Hypothesis is so embarrassed and perplexed, that it hath had few Espousers : And, instead of it, *Longomontanus*, and some few others have advanced another Hypothesis, that may be called *Semi-Tychonian* ; in which, holding all things according to *Tycho*, they allow a *Diurnal Motion* to the Earth, though they deny an *Annual* one. But though this be a good deal more probable than the *Tychonian System*, yet it is still so intricate and confused, and so inconsistent with Observation, and the simple uniform Laws of Nature, which establish the *Pythagorean* or *Copernican* Hypothesis ; that I shall say no more of it, but that 'tis not worth while for any one to enquire into it, nor to invent Laws to solve it ; since all the *Phænomena* of the Heavenly Bodies are much better accounted for in the other System last mentioned. See *Greg. Astronom. Book I. Sect. II.*

TYLWITH, in *Heraldry*, a Tribe or Family branching out of another, which modern *Heralds* call the second or third House.

TYMPAN [*τύμπανον*, Gr.] in Architecture, is that Part of the Bottom of the *Frontons*, which is enclosed between the *Cornices*, and answers the Nailed of the *Frise*.

TYMPAN of an Arch, is a Triangular Table placed in its Corners.

The most simple of these *Tympans* have only a Table hollow'd, sometimes with the Branches of *Lawrel, Olive-Tree, or Oak*, or with *Trophies*,

and are conformable to the *Dorick* and *Ionick* Orders. But the richest are adorned with flying Figures ; as *Fame* ; or sitting Figures, as those of the *Cardinal Virtues*, and are proper for the *Corinthian* and *Composit* Orders.

*Tympan*, is also attributed to the Pannels of Doors in Joiners Work, and to the Dye or Square of Pedestals.

TYMPANITES [*of τυμπανίζω*, Gr. to sound like a Drum] *Tympanias*, the Disease call'd the *Tympany*, is a fix'd, constant, equal, hard, resisting Tumour of the *Abdomen*, which being beat or struck, yields a Sound. It proceeds from a stretching Inflation of the Parts, and of the Membranaceous Bowels, whose Fibres are too much swollen with Animal Spirits, and hindered from receding by the Nervous Juice which obstructs the Passage ; to which Distemper there is consequently added, as the Compliment of all, an abundance of flatulent Matter in the Places that are empty. *Blanchard*.

TYMPANUM [*τύμπανον*, Gr.] or rather *Tympani Membrana*, the Drum, or the Skin of the Drum of the Ear, is a small, thin, orbicular, transparent, nervous and dry Membrane of most exquisite Sense, stretched over the Cavity of the inner Part of the Ear, and dividing between the inward and outward Ear. Some will have it spring from the *Pericranium*, others from the *Dura-mater*, others from the *Pia-mater*, and others from the softer Process of the auditory Nerve there expanded ; and there are some Anatomists which believe it hath a Substance proper to itself, made in the first Formation of the Parts, and springing from nothing else. It is very dry, that it may give the better Sound ; and strong, to bear external Injuries the better. It is enclafed in a Channel made in the Circumference of the outer End of the Bone that joins to the Cartilage which forms the largest Part of the *Meatus Auditorius* ; and it hath a Cord which runs a-cross it behind, which some take for a Ligament to strengthen it ; but *Verney* saith, 'tis a Branch of the 7th Pair of Nerves which supplies Twigs to the Muscles that move the *Tympanum*, which are two in Number. When this *Membrana Tympani* is taken away, there appears a Cavity on the inside of it, which is properly the *Tympanum* ; but *Verney* will call it the *Barrel*. It is about a Quarter of an Inch long, and half an Inch wide ; 'tis compassed round with Bone, and clad within with a Membrane, which is interwoven with a great Number of Vessels. How Sounds are distinguish'd by means of this *Membrana Tympani*, and the four Bones, *Malleolus, Incus, Stapes*, and the *Os Orbiculare*, you will find at large under the Word *Ear*.

TYMPANUM, in Mechanics, is a Cylinder, but larger and shorter than the common Axis or Cylinder, which is the *Axis in Peritrochio*, and 'tis usually placed upon that Axis, and is much the same with the *Peritrochium*, which is a kind of Wheel placed on the Axis, in whose Circumference are Staves or Levers to turn the Axis easily about, in order to raise the Weight required.

TYPHODES, [*τυφώδης*, Gr.] is a symptomatical continued burning Fever, as it were from the Inflammation of the Bowels. *Blanchard*.



**TYPHOMANIA**, is a *Delirium* with a Phrensy and a Lethargy. *Blanchard*.

**TYPHOMANIA** [of τυφος, *Smoak*, and μανία, *Gr. Madness*] a Disease of the Brain, in which the Patient cannot sleep, tho' greatly inclin'd so to do, but lies with his Eyes shut, talks deliriously, and is very restless, flinging himself this way or that way; or, as others define it, a *Delirium* with a Frenzy and Lethargy.

**TYPOGRAPHY** [τυπογραφία, *Gr.*] the Art of *Printing*.

**TYPUS**, *Periodus* and *Circuitus*, is the Order that intermitting Fevers observe, consisting of Intension and Remission, of Encreasing and Decreasing, according to some kind of Regularity; and accordingly denominating the kind of the Fever by its *Type*. *Blanchard*.

**TYROSIS**, [τύρσις of τυρός, *Gr. Cheese*] is when Milk which is eaten, curdles in the Stomach into a Substance like Cheese. *Blanchard*.

**TYTHES**, are of three Sorts. (1.) *Prædial* which *Tythes*, which arise wholly or chiefly from the Earth; as of Corn, Hay, Underwood, Fruits, &c. (2.) *Mixt Tythes* are such as arise from Beasts, and other Animals pastured or fed with the Fruits of the Earth; as Colts, Calves, Lambs, Wool, Milk, Fowls, &c. (3.) *Personal Tythes*, which are the Profits arising from the Labour, Art, Trade, Negotiation and Industry of Men. *Great Tythes* are the Tenth's of Corn, Hay and Wood only; all others being called *Small Tythes*.

## V A C

## V A C

**VACANCY**, in *Physicks*, an empty Interval or Space void of Matter.

**VACANCY**, in *Law*, &c. a Post or Benefice wanting a regular Officer or Incumbent.

**VACANT Effects**, in *Law*, are such as are abandoned for want of an Heir, after the Death or Flight of their former Owner.

**VACATION**, by the Lawyers, is all the respective Time betwixt the End of one Term, and the Beginning of another.

It signifies also the Time from the Death of a Bishop, or other spiritual Person, 'till the Bishoprick, or other Dignity, be supplied with another.

**VACUUM**, is by Physiologists, supposed to be a Space devoid of all Body: And this they distinguish into a *Vacuum Disseminatum*, or *Interspersum*; i. e. small void Spaces interspersed about between the Particles of Bodies.

Or, a *Vacuum Coacervatum*, which is a larger void Space made by the meeting together of the several interspersed or disseminate Vacuities before mentioned.

That there is a *Vacuum*, at least a *Disseminate* one, seems clear from the following Arguments.

1. That without supposing some interspersed Vacuities among Bodies, 'tis very hard to account for Motion: For, if there be an absolute *Plenum*, the least Body in Nature cannot move, but all Bodies that are, must move with it; and yet into what Places they should move, when all Things are already full, is as hard to conceive as the former.

2. Without allowing a *Vacuum*, how can there be any such Thing as either *Rarefaction*, or *Con-*

*densation*? For if all Space is adequately full of Body, nothing can possibly ever take up a greater or lesser Room than it had at first; and yet we find by evident Experience, that Air is capable of a very great Degree of Compression, and that Water can be rarified into Air or Vapour, and then take up vastly larger Room than it did before.

3. Sir *Isaac Newton* found, that the Weight of Bodies doth, by no Means, depend on their Forms or Textures, but that all Bodies at equal Distances from the Earth, do equally gravitate towards it in Proportion to the Quantity of Matter in them, which is every where as their Weight: Wherefore, *there must of Necessity be a Vacuum*: For, if all Places were full, there could be no Difference in the Specifick Gravity of Bodies, but Air would be intensively as heavy as Gold; and so Gold could not descend in Air, and much less any lighter Body than it; which would contradict all the received Laws of Hydrostaticks, though confirm'd by ten Thousand Experiments.

**VACUUM**: To what has been said on this Subject, may be added by way of Illustration; That since all Bodies do (by what Sir *Isaac Newton* aptly calls the *Vis Inertiæ*) resist as far as they can, any Change or Alteration of their present State, whether of Motion or Rest; and since this Resistance is always the same in the same Body, and in different Bodies is proportionable to the Quantity of Matter they contain: And since also, of consequence, if two Bodies contain equal Quantities of Matter, and move towards one another with contrary Directions and equal Velocities, they will necessarily both stop at the Point of Concourse: And, *conversely*, since 'tis certain



certain also that two Bodies moving thus, with contrary Directions and equal Celerities, if at the Point of Concourse they do both rest, must be equally heavy: It plainly follows, that two Bodies, containing each an equal Quantity of Matter, must be equally heavy; wherefore, were there no such Thing as Porosity or Vacuity, two Spheres of equal Diameters, must contain equal Quantities of Matter, and be equally heavy; that is, two Spheres of different Matter, suppose one of Wood, and the other of Gold, if they had equal Diameters, must have equal or the same Specifick Gravities. But this being directly contrary to all Experience, there is an unavoidable necessity of supposing Vacuities in the Sphere of Wood, to render it lighter, bulk for bulk, than that of Gold.

The Planetary Regions in which the heavenly Bodies move, must needs be almost devoid of all Body or Matter; for otherwise a *Resistance* must accrue to the Planets Motions, which tho' never so small, would in time be sensible, and have an Effect in retarding the Motion of the heavenly Bodies; but no such Thing hath ever yet been observed or discovered, but the contrary is certain. And besides, such a thin Vapour as the Tail of a Comet, can move through the *Æther*, as some will call it, with incredible Swiftmess, without being dissipated or drawn from its natural Course; which is in itself a Demonstration, that there must be a kind of *Vacuum* in those Celestial Regions. And Dr. *Hook*, who was a *Plenist*, saith, That the vast *Expansum* of the World must be a Body so exceedingly fluid (that is *no Body at all*) as hardly to hinder the Motion of any Body through it. And Sir *Isa. Newton* shows, p. 313. of his *Latin Opticks*, That if the Planetary Regions were, as the *Plenists* assert, entirely full of Matter, and without any interspersed Vacuities at all, let their Matter be never so subtle and fluid, they would have a greater Resistance to any Bodies moving in them, than Mercury or Quick-silver hath. And in such a Medium as That, even a perfectly solid Globe must lose half its Motion, before it can move thrice the Length of its own Diameter. And Globes or Spheres, such as the Planets are, would be stopp'd much sooner; wherefore 'tis absolutely necessary, for continuing the Motions of the Planets and Comets, that the Places they move in be almost entirely devoid of all Matter.

The feigned Romantick Subtile Matter with which the *Cartesians* have filled the Celestial Regions, and all other Parts of the Universe, is by no means useful to explain the Phænomena of Nature: since the Motions of the Planets and Comets are much better explained by *Gravitation* without it, and the Cause and Nature of Gravity hath not yet been explained by that *Materia Subtilis*, nor I believe ever can be. And if there were any such Thing as that Matter, it would only serve to do mischief, to disturb and retard the Motions of the Heavenly Bodies, and the Order and Course of Nature. And if there were any such Thing within the hidden Pores and *Meatus* of Bodies, it would serve for no good Purpose; it would only hinder and stop the vibrating Motion of their Parts, in which their Heat and all their active Force consists.

That Whim therefore of the *Materia Subtilis*, must be entirely banished out of our Philosophical Faith; and then, along with it, will sink all those imaginary Schemes and Hypotheses, for the ex-

plaining the Nature of the Phænomena of Light, by the means of *Pressure* or the *Motion* of the *Medium*. See *Pressure*.

*VACUUM*, *Vacuity*, in *Physicks*, a Space empty, or devoid of all Matter; or Body. See *Space* and *Matter*.

Whether there be such a Thing in Nature as one absolute *Vacuum*, or whether the Universe be completely full, and there be an absolute *Plenum*, is a Thing has been controverted by the Philosophers of all Ages. See *Plenum*.

The Ancients in their Controversies distinguish two Kinds, a *Vacuum Coacervatum*, and a *Vacuum Interspersum* or *Disseminatum*.

*Vacuum Coacervatum*, is conceived as a Place destitute of all Matter, such, e. g. as there would be, should God annihilate all the Air and the Bodies within the Walls of this Chamber. The Existence of such a *Vacuum* is maintain'd by the *Pythagoreans*, *Epicureans*, and the *Atomists* or *Corpuscularians*; most of whom assert such a *Vacuum* actually to exist without the Limits of the sensible World: But the modern *Corpuscularians*, who hold a *Vacuum Coacervatum*, deny that Application, as conceiving that such a *Vacuum* must be infinite, eternal, and uncreated. See *Universe*.

According then to the later Philosophers, there is no *Vacuum Coacervatum* without the Bounds of the sensible World, nor would there be any *Vacuum*, provided God would annihilate diverse contiguous Bodies, than what amounts to a mere Privation, or Nothing: The Definition of such a Space, which the Ancients held to be Real, being by these held to be mere Negations, that is, in such a Place there is so much Length, Breadth and Depth wanting, as a Body must have to fill it. To suppose, that when all the Matter in a Chamber is annihilated, there should yet be real Dimensions, is to suppose Corporeal Dimensions without Body, which is absurd.

The *Cartesians*, however, deny any *Vacuum Coacervatum* at all, and assert, that if God should immediately annihilate all the Matter, e. g. in this Chamber, and prevent the Ingress of any other Matter, the Consequence would be, that the Walls would become contiguous, and include no Space at all. They add, that if there be no Matter in a Chamber, the Walls can be conceived no otherways than as contiguous, those Things being said to be contiguous, between which there is not any Thing intermediate: But, if there be no Body between, there is no Extension between; Extension and Body being the same Thing, and if there be no Extension between, then the Walls are contiguous, and where's the *Vacuum*?

But the Reasoning is built upon a Mistake, viz. that Body and Extension are the same Thing. See *Extension* and *Space*?

*Vacuum Disseminatum*, or *Interspersum*, is that supposed to be naturally interspersed in, and among Bodies, in the Pores of the same Body, and in the Interstices between different Bodies. See *Pores*.

'Tis this Kind of *Vacuum* which is chiefly disputed among the modern Philosophers: The *Corpuscularians* strenuously asserting it, and the *Peripateticks* and *Cartesians* as stiffly impugning it. See *Corpuscular*, *Cartesian*, &c.

The great Argument the *Peripateticks* urge against a *Vacuum Interspersum*, is, that there are diverse Bodies seen to move contrary to their own Nature and Inclination, and for no other apparent



Reason, but to avoid a *Vacuum*; whence they conclude, that Nature abhors a *Vacuum*, and give us a new Class of Motions ascribed to the *Fuga Vacui*, or Nature's flying a *Vacuum*. See *Fuga*.

Such is the Rise of Water in a Syringe, upon drawing up a Piston; such also is the Ascent of Water in Pumps, the Swelling of the Flesh in a Cupping-Glass, &c.

But since the Weight, Elasticity, &c. of the Air have been ascertain'd by sure Experiments, those Motions and Effects are absolutely ascrib'd to Gravity and Pressure of the Atmosphere. See *Air*; See also *Syringe*, *Pump*, *Cupping-Glass*, &c.

The *Cartesians* deny not only the actual Existence, but even the Possibility of a *Vacuum*, and that on this Principle, that Extension being the Essence of Matter or Body, wherever Extension is, there is Matter: But mere Space or Vacuity, is supposed to be extended; therefore it is material. Whoever denies an empty Space, conceives Dimensions in that Space, *id est*, conceives an extended Substance in it, and therefore admits a *Vacuum* at the same Time that he admits it.

On the other Hand the *Corpuscular* Authors prove, not only the Possibility, but the actual Existence of a *Vacuum* from divers Considerations, particularly from the Consideration of Motion in general; and that of the Planets, Comets, &c. in particular, from the Fall of Bodies, from the Vibration of Pendulums, from Refraction and Condensation, from the different specific Gravities of Bodies, and from the Divisibility of Matter into Parts.

1. 'Tis argued that Motion could not be effected without a *Vacuum*. See *Motion*.

This is what *Lucretius* urged long ago ——— *Principium quoniam cedendi nulla daret res ——— undique Materies quoniam stipata fuisset*. The Force of this Argument will be increased from the Two following Considerations, *viz.* First, That all Motion is either in a straight Line, or in a Curve, which returns into it self, as the Circle and Ellipsis; or in a Curve, that does not return into it self, as the Parabola, &c. And, Secondly, That the moving Force must always be greater than the Resistance.

For, hence it follows, that no Force, even the Infinite, can produce Motion where the Resistance is infinite; consequently, there can be no Motion, either in a straight Line, or a non-returning Curve; because in either of those Cases, the Protrusion and, consequently, the Resistance, would be infinite; there remains, therefore, only the Motion in a revolving Curve practicable; which must either be a Revolution upon an Axis, or an annular Motion round a quiescent Body, both which are impossible again in an Elliptic Curve, and consequently all Motion must be in Circles geometrically true, and the revolving Bodies must either be Spheres, Spheroids, Cylinders, or Portions of them exactly geometrical, otherways their Revolutions in a *Plenum* would be impossible: But such Motions or figur'd Bodies we do not know in Nature; Therefore there is a *Vacuum*.

2. The Motions of the Planets and Comets demonstrate a *Vacuum*.

Thus Sir *Isaac Newton* argues; "That there is no such fluid Medium as *Æther* (to fill up the porous Parts of all sensible Bodies, as the Air and inter-stellar Parts, and so make a *Ple-*

*num*) seems probable; because the Planets and Comets proceed with so regular and lasting a Motion through the Celestial Spaces, both from, and to all Parts: For, hence it appears, that those Celestial Spaces are void of all sensible Matter. For, the Resisting Force of Fluid Mediums arises partly from the Attraction of the Parts of the Medium, and partly from the Inactivity of Matter. Now, that Part of the Resistance of any Medium, which arises from the Tenacity or Attrition of its Parts, may be lessened by dividing the Matter into smaller Parts, and by rendring those Parts more smooth and slippery: But that Part of the Resistance which arises from the Inactivity of Matter, is always in Proportion to the Density of the Matter, nor can be diminished by dividing the Matter, nor by any other Means, except by diminishing the Density thereof.

"Consequently, if the Celestial Regions were as dense as Water or Quick-silver, they would resist almost as much as Water or Quick-silver: But if they were perfectly dense, without any interspers'd Vacuity, tho' the Matter were ever so fluid and subtile, they would resist more than Quick-silver does; a perfectly solid Globe in such a Medium would lose above half its Motion in moving three Lengths of its Diameter, and a Globe not perfectly solid, such as the Bodies of the Comets and Planets are, would be stopp'd still sooner. Therefore, that the Motion of the Planets may be regular and lasting, it is necessary the Celestial Spaces be void of all Matter, except perhaps some few and much rarified Effluvia of the Planets and Comets, and the passing Rays of Light. See *Resistance*, *Medium*, *Planet*, *Comet*, &c.

3. The same Author deduces a *Vacuum* from the Consideration of the Weights of Bodies, thus; "All Bodies about the Earth gravitate towards the Earth; and the Weights of all Bodies equally distant from the Earth's Center, are as the Quantities of Matter in those Bodies: If the other, therefore, or any other subtile Matter, were altogether destitute of Gravity, or did gravitate less than in Proportion to its Quantity of Matter; because (as *Aristotle*, *Des Cartes*, and others argue) it differs from it, it differs from other Bodies only in the Form of the Matter, the same Body might, by the Change of its Form, gradually be converted into a Body of the same Constitution with those which gravitate most in Proportion to the Quantity of Matter; and on the other Hand, the most heavy Bodies might gradually lose their Gravity, by gradually changing their Form, and therefore the Weights would depend upon the Forms of Bodies, and might be changed with them, which is contrary to all Experiments." See *Weight*.

4. "The Descent of Bodies proves, that all Space is not equally full; for the same Author goes on; If all Spaces were equally full, the specific Gravity of that Fluid with which the Region of the Air would in that Case be-filled, would not be less than the specific Gravity of Quicksilver or Gold, or any other the most dense Body; and therefore neither Gold nor any other Body could descend therein; for Bodies do not descend in a Fluid, unless that Fluid  
" be



“ be specifically lighter than the Body. But by  
 “ the Air-Pump we can exhaust a Vessel till even  
 “ a Feather shall fall with a Velocity equal to  
 “ that of Gold in the open Air : The Medium  
 “ therefore, through which the Feather falls, must  
 “ be much rarer than that through which the Gold  
 “ falls.” See *Descent*.

“ The Quantity of Matter, therefore, in a given  
 “ Space may be diminished by Rarefaction, and  
 “ why may not it be diminished in *Infinitum* ?  
 “ Add, that we conceive the solid Particles of all  
 “ Bodies to be of the same Density, and that they  
 “ are only Rarefiable by means of their Pores ;  
 “ whence a *Vacuum* evidently follows.” See *Rarefaction, Pores and Particles*.

5. “ That there is a *Vacuum*, is evident from  
 “ the Vibrations of Pendulums : For, since those  
 “ Bodies, in Places out of which the Air is ex-  
 “ hausted, meet with no Resistance to retard their  
 “ Motion, or shorten the Vibrations, 'tis evident  
 “ there is no sensible Matter in those Spaces, or  
 “ in the occult Pores of those Bodies.” See *Pendulum*.

For, as to what *Des Cartes* urges of his *Materia subtilis*, that its Tenuity prevents its Resistance from being sensible, and that a small Body striking against a greater, cannot in the least move or resist the Motion of that other, but is reflected back with all its Momentum ; 'tis contrary to all Experience : For Sir *Isaac* proves, that the Density of fluid Mediums is proportionable to their Resistance very nearly, and that they are exceedingly mistaken who suppose the Resistance of Projectiles to be infinitely diminished by dividing the Parts of the Fluid, even in *Infinitum*. (*Princip. Lib. II. Prop. 38.*) When on the contrary 'tis clear, the Resistance is but little diminished by the Sub-division of the Parts, (*Ibid. Prop. 40.*) and that the Relisting Forces of all Fluids are nearly as their Densities. For why should not the same Quantity of Matter, whether divided into a great Number of Subtile Parts, or into a few larger ones, have the same Resisting Force ?

If then there were no *Vacuum*, it would follow, that a Projectile moving in the Air, or even in a Space whence the Air is exhausted, should move with as much Difficulty as in Quick-silver, which is contrary to Experience. See *Projectile*.

6. That there are Interspers'd Vacuities, appears from Matters being actually divided into Parts : For, on Supposition of an absolute Plenitude, we do not conceive how any Parts of Matter could be actually divided from that next adjoining, any more than it is possible to divide actually the Parts of absolute Space from one another ; for, by the actual Division of the Parts of a *Continuum* from one another, we conceive nothing else understood but the placing those Parts at Distances from one another, which in the *Continuum* were at no Distance from one another : But such Divisions between the Parts of Matter must imply Vacuities between. See *Divisibility*.

7. As for the Figures of the Parts of Bodies, upon the Supposition of a *Plenum*, they must either be all Rectilineal or Concave Convex ; otherways they would not adequately fill Space, which we do not find to be true in Fact.

8. The Denying of a *Vacuum* supposes what it is not possible for any one to prove to be true, that the Material World hath no Limits. See *Universe*.

Since then the Essence of Matter does not consist in Extension, but in Solidity or Impenetrability, the Universe may be said to consist of solid Bodies moving in a *Vacuum* ; nor need we at all fear least the Phænomena of Nature, most of which are plausibly accounted for from a Plenitude, should become inexplicable, when the *Plenum* is set aside. The principal ones, such as the Tides ; the Suspension of the Mercury in the Barometer ; the Motion of the Heavenly Bodies, of Light, &c. are more easily and satisfactorily accounted for from other Principles. See *Tides, &c.*

*Vacuum*, or *Vacuum Boyleanum*, is also used, somewhat abusively, to express that Approach to a Real *Vacuum* which we arrive at by Means of the Air-Pump. See *Air-Pump*.

Thus any Thing put in a Receiver, so exhausted, is said to be put in *Vacuo* ; and thus most of the Experiments on the Air-Pump are performed in *Vacuo*, or in *Vacuo Boyleano*.

Some of the particular Phænomena observed of Bodies in *Vacuo*, are, that the heaviest and lightest Bodies, as a Guinea and a Feather, fall here with equal Velocity. — That Fruits, as Grapes, Cherries, Peaches, Apples, &c. keep for any time in *Vacuo*, retain their Nature, Freshness, Colour, &c. and those withered in the open Air recover their Plumpness in *Vacuo*. — All Light and Fire becomes immediately Extinct in *Vacuo*. — The Collision of Flint and Steel in *Vacuo* produce no Sparks. No Sound is heard, even from a Bell rung in *Vacuo*. — A Square Viol, full of common Air well clos'd, breaks in *Vacuo*, a Round one does not. — A Bladder, half full of Air, will heave up 40 Pound Weight in *Vacuo*. — Cats and most other Animals readily expire in *Vacuo*. —

By Experiments made in 1704, Mr. *Derham* found that Animals which have two Ventricles and no *Foramen Ovale*, as Birds, Dogs, Cats, Mice, &c. die in less than half a Minute, counting from the first Exsuction ; a Mole died in one Minute ; a Bat lived seven or eight ; Insects, Wasps, Bees, and Grass-hoppers, seem'd dead in two Minutes, but being left in *Vacuo* 24 Hours, came to Life in open Air ; Snails continued 24 Hours in *Vacuo*, without appearing much concern'd.

Seeds planted in *Vacuo* do not grow. — Small Beer dies and loses all its Taste in *Vacuo*. — Luke-warm Water boils very vehemently in *Vacuo*. — Air rushing thro' Mercury into a *Vacuum*, throws the Mercury into a Kind of Shower upon the Receiver, and produces a great Light in a dark Room. See *Attrition*.

The Air-Pump can never produce a precise *Vacuum*, as is evident from its Structure and the Manner of its working ; in Effect every Exsuction only takes out a Part of the Air, so that there will still be some left after an infinite Number of Exsuctions. Add, that the Air-Pump has no longer any Effect, than while the Spring of the Air remaining in the Receiver is able to lift up the Valves : When the Rarefaction is come to that Degree, you can come no nearer to a *Vacuum*.

Sir *Isaac Newton* observing that a Thermometer suspended in *Vacuo*, and in that State removed  
to



to a warm or a cold Room, receives the Heat or Cold, rises or falls almost as soon as another not in *Vacuo*, takes thence Occasion to suspect, that the Heat of the warm Room is conveyed through the *Vacuum* by the Vibrations of a much subtiler Medium than the Air which remain'd in the *Vacuum*, which was drawn out, (*Opt. p. 323.*) See *Medium, Heat.*

Dr. *Nieuwentyt* and some others say, That Particles of Fire, separated from the Sun's Beams, by adhering to Particles of Water, make up *Molecularæ* or small Bodies, specifically lighter than Air; which therefore, by Hydrostatical Laws, must rise and form Clouds that remain suspended when they are risen up to such an Height, that the Air about them is of the same specifick Gravity with themselves.

That Rain is produced by the Separation of the Particles of Fire from those of Water; which last being then restored to their former specifick Gravity, can no longer be sustain'd by the Air, but must fall in Drops. See *Nieuwentyt's Religious Philosopher*, Contemplation 19th, from Section 13th to Section 15th.

1. Now this is liable to several Objections; *First*, it is built upon a Supposition that Fire is a particular Substance or distinct Element, which has never yet been proved by convincing Experiments and sufficient Observations, and which the Reverend Mr. *Hales* has in his late excellent Book of *Vegetable Statics* shewn to be an ill-grounded Opinion, making it very plain, that in Chymical Operations those Bodies which had been thought to become heavier by Particles of Fire adhering to them, were only so by Adhesion of Particles of Air, &c. which he has shown to be absorbed in great Quantities by some Bodies, whilst it is generated (or reduced from a *fixt* to an *elastick* State) by others; nay, that it may be absorbed and generated successively by the same Body under different Circumstances.

2. *Secondly*, If we should allow the above-mentioned Supposition, the Difficulty will still remain about the Production of Rain by the Separation of the Fire from the Water: For, Dr. *Nieuwentyt* ascribes this Effect to two different Causes. *First*, to Condensation (*Seet. 23.*) saying "That when contrary Winds blow against the same Cloud, and drive the watry Particles together, the Fire that adhered to them gets loose, and they (being then specifically heavier) precipitate and fall down in Rain." Then, in the very next Section, he ascribes it to Rarefaction, when he says, "That when a Wind blowing obliquely upwards causes a Cloud to rise into a thinner Air (*i. e.* specifically lighter than it self) the Fire, which by sticking to the Particles, render'd them lighter, extricates it self from them, and ascending by its Lightness, the Water will become too heavy, not only to remain in this thin and light Air, but even in a thicker and heavier near the Earth, and so will be turn'd into a descending Dew, Mist, or Rain, or Snow, or the like, according as the watery Particles are rarefied or compressed." The first of these Causes of Rain is contrary to Experience; for, when two contrary Winds blow contrary to each other over any Place of the Earth, the Barometer always rises, and we have fair Weather: For then (as Mr. *Halley* says, in *Philosophical Transactions*, N<sup>o</sup> 183.) the

Air being accumulated above, becomes specifically heavier about the Clouds, which (instead of falling into Rain; as Dr. *Nieuwentyt* supposes) ascend up into such a Part of the Atmosphere as has the Air of the same specifick Gravity with themselves.

If the Falling of Rain might be attributed to the second of these Causes, then every time that a Cloud is encompassed with Air specifically lighter than it self (whether it be when by the blowing away some of the superior Air; that which is about the Cloud becomes rarer as it is less compressed, or by the Cloud being driven upwards) Rain must necessary follow; whereas one may often see the Clouds rise and fall without Rain, even when the Barometer shews the Weight of the Air to be alter'd: For that happens only when, by the great Diminution of the specifick Gravity of the Air about the Cloud, it has a great Way to fall; in which Case the Resistance of the Air, which increases as the Square of the Velocity of the descending Cloud, causes the floating Particles of Water to come within the Power of each other's Attraction, and from such big Drops, as being specifically heavier than any Air, must fall down in Rain.

No gentle Descent of a Cloud; but only an accelerated Motion downwards, produces Rain.

N. B. *I don't mean that the quick Descent of a Cloud is the only Cause of Rain; because the Shock from a Flash of Lightning and the sudden Return of the Air, after the Vacuum made by the Flash, will condense the floating Vapour into Water, and also the same Cloud which in the Air might be carried horizontally without being turned into Rain, meeting with an high Hill in its way, will be condensed and fall in Drops, especially if in the Day-time it be driven by the Wind out of the Sun-shine against the shaded Side of the Mountain.*

Besides all this, if Particles of Fire were joined with those of Water to raise them up, those igneous Particles must be at least a thousand times greater in Bulk than the watery ones; so that a Person who, at the Top of a Hill, has his Hands and Face in a Cloud, must feel a very sensible Warmth, by touching a much greater Surface of Fire than Water in the Cloud, and afterwards find the Rain produced from that Vapour sensibly colder; whereas the contrary is proved by our Senses; the Tops of Hills, tho' in the Clouds, being much colder than the Rain at Bottom.

There is another Opinion concerning the Rise of Vapours, namely, that the Water be specifically heavier than Air; yet if its Surface be increased by very much diminishing the Bulk of its Particles, when once rais'd it cannot easily fall; because the Weight of each Particle diminishes as the Cube-Root of its Diameter, and the Surface to which the Air resists, only as the Square-Root of the said Diameter: That we see this in the Dust in Summer, and in *Menstruums* that sustain Metals dissolved, which are specifically heavier than the *Menstruums*.

But this will not explain the Phenomenon, because, tho' the Increase of the Surface (the Weight remaining the same) will in a great measure hinder (or rather retard) the Descent of small Bodies moving in the Air, by Reason of its great Resistance to so large a Surface; it will for the same Reason also hinder the Ascent. For the

Rise



Rise of Dust is owing to the Motion of Animals Feet in it, or to the Wind; whereas Vapours rise in calm Weather as well as windy; neither do they, like the Dust, always fall to the Ground when the Wind ceases to blow.

The third Opinion, and which is most commonly received, is, that by the Action of the Sun on the Water, small Particles of Water are form'd into hollow Spherules, fill'd with an Aura, or finer Air highly rarified, so as to become specifically lighter than common Air, and consequently, that they must rise in it by Hydrostatical Laws. As for Example, if a Particle of Water, as it becomes a hollow Sphere, be only increased ten times in Diameter, its Bulk will be increased a thousand times; therefore it will then be specifically lighter than common Water, whose specifick Gravity is to that of Air, as 850 to 1; then if the Density of the Aura or Spirit within the little Shell be supposed nine times less than that of Air, or as 50 to 850, that specifick Gravity of the Shell and its Contents will be to that of Air, as 900 to 1000; therefore such an aqueous Bubble must rise until it comes to an Equilibrium in Air, whose Density is to the Density of that in which it began to rise, as 850 to 945 nearly. But it appears by Experiments, that Air rarified by an Heat which makes a Retort red-hot, is only increased in Bulk, or dilated three times; by the Heat of boiling Water only  $\frac{1}{4}$ , or near two Thirds; and by the Heat of the human Body (such as will raise Vapours plentifully) only  $\frac{1}{39}$ , or about  $\frac{1}{4}$ . I own my Objection may be answered, by supposing the Sphericle of Water to be more increased in Diameter, as for Example 20 times; because, then if it be filled with Air only  $\frac{1}{4}$  rarer than common Air, it will be specifically lighter, and capable of rising to a considerable Height. To give this Solution all its Force, let us express it in Numbers.

Let A and W represent a Particle of Air, and one of Water of equal Bulk, then will the Weight of A be to the Weight of W, as 1 to 850, their Bulks being equal. If the Particle of Water be blown up into a Bubble of 20 times its Diameter, then will its Bulk be to its Weight as 8000 to 850, whilst a Sphere of Air of the same Bigness has its Weight as well as Bulk equal to 8000: Now, if an Air or Aura  $\frac{1}{4}$  rarer than common Air be supposed within the watery Bubble to keep it blown, it will be the same as if  $\frac{3}{4}$  of the Air of one was carried into the other, and then the Weight of one would be increased by the Number 6000; so that the Shell of Water being in Bulk 8000, would be in Weight  $850 + 6000 = 6850$ , whilst an equal Bulk of Air weighed 8000, and consequently the watery Bubble would rise till it came to an Air whose Density is to the Density of the Air next the Surface of the exhaling Water, as 6850 to 8000.

This is the strongest Way of stating the Hypothesis; but to support it, the following Queries must be answered.

*Query 1.* How comes the Aura, or Air, in the Bubbles to be specifically lighter than the Air without them, since the Sun's Rays, which act upon the Water, are equally dense all over its Surface.

*Query 2.* If it could be possible for rarer Air to be separated from the denser ambient Air, to blow up the Bubbles (as Bubbles of soaped Water are blown up by warm Air from the Lungs, whilst

the ambient Air is colder and denser) what would hinder that cold Air by its greater Pressure, from reducing the Bubbles to a less Bulk and greater specifick Gravity than the Air, especially since Cold can be communicated through such thin Shells, and the Tenacity of common Water is very small, when compared to that of soaped Water, whose Bubbles, notwithstanding that Tenacity, are soon destroyed by the Pressure of the outward Air, as the Air within them cools?

*Query 3.* If we should grant all the rest of the Suppositions, yet this Difficulty will remain: If Clouds are made up of hollow Shells of Water filled with Air, why do not those Clouds always expand when the ambient Air is rarified, and presses less than it did before, and also suffers a Condensation, as the ambient Air is condensed by the Accumulation of the superior Air?

If this Condensation and Rarefaction should happen to the Clouds, they would always continue at the same Height, contrary to Observation, and we should never have any Rain.

From all this it follows, that the Condensation and Rarefaction of the Vapours which make Clouds, must depend upon another Principle than the Condensation and Rarefaction of the Air; and that there is such a Principle, I shall endeavour to show.

#### L E M M A.

The Particles of all Fluids have a repellent Force: Fluids are elastick or un-elastick: The elastick Fluids have their Density proportional to their Compression; and Sir *Isaac Newton* has demonstrated (*Princip. Lib. II. Sect. 3.*) that they consist of Parts that repel each other from their respective Centers. Unelastick Fluids, like Mercury, Water and other Liquors, are by Experiments found to be incompressible; for Water in the *Florentine* Experiment could not by any Force be compelled into less Room, but ooz'd like Dew through the Pores of the hollow golden Ball in which it was confined, when a Force was applied to press the Ball out of its spherical into a less capacious Figure. Now, this Property of Water and other Liquors must be entirely owing to the centrifugal Force of its Parts, and not its Want of Vacuity; since Salts may be imbibed by Water without increasing its Bulk, as appears by the Increase of its specifick Gravity. So Metals which (singly) have a certain specifick Gravity beyond which they cannot be condensed, will yet receive each other in their Interstices, so as to make a Compound specifically heavier than the heaviest of them, as is experienced in the Mixture of Copper and Tin.

#### S C H O L I U M.

By increasing the repellent Force of the Particles, an unelastick or incompressible Fluid may become elastick, or a Solid (at least a great Part of it) may be changed into an elastick Fluid; and *vice versa*, by diminishing the repellent Force an elastick Fluid may be reduced to an unelastick one, or to a Solid. That the Particles of Quick-silver, Water, and other Liquors are likewise endued with an attractive Force, is evident from those Substances running into Drops in an exhausted Receiver, as well as in the Air, and likewise their adhering to other Bodies. The Attraction



and Repulsion exert their Forces differently. The Attraction only acts upon the Particles, which are in Contact, or very near it; in which Case it overcomes the Repulsion so far, as to render that Fluid unelastick, which otherways would be so; but it does not wholly destroy the Repulsion of the Parts of the Fluid, because it is on Account of that Repulsion that the Fluid is then incompressible. When by Heat or Fermentation (or any other Cause, if there be any) the Particles are separated from their Contact, the Repulsion grows stronger, and the Particles exert that Force at great Distances; so that the same Body shall be expanded into a very large Space by becoming fluid, and may, sometimes, take up more than a Million of times more Room than it did in a solid or incompressible Fluid (See the Queries at the end of Sir Isaac Newton's Opticks.) Thus is Water by boiling, and less Degrees of Heat, changed into an elastick Vapour, rare enough to rise in Air, Oils and Quicksilver in Distillation made to rise in a very rare Medium, such as remains in our red-hot Retort, and sulphurous Steams will rise, even in an exhausted Receiver, as the Matter of the *Aurora Borealis* does in the thinner Part of the Atmosphere. If *Aqua-fortis* be poured on Quicksilver, a reddish Fume will rise much lighter than common Air; so also will Fumes rise from Filings of Metals, from Vegetables when they ferment by Putrefaction; and (as the Reverend Mr. Hales has shown) several solid Substances, by Distilling as well as Fermentation, will generate permanent Air. — That Heat will add Elasticity to Fluids, is evident from innumerable Experiments, especially from Distilling and Chymistry: But what is needful to consider here, is only that it acts more powerfully on Water than common Air; for the same Heat which rarifies Air only  $\frac{1}{3}$ , will rarify Water very near 14000 times, changing it into Steam or Vapour as it boils it: And in Winter, that small Degree of Heat, which in respect to our Bodies appears cold, will raise a Steam or Vapour from Water at the same time it condenses Air.

By a great many Observations made by Mr. Henry Beighton, F. R. S. and myself, upon the Engine to raise Water by Fire, according to Mr. Newcomb's Improvement of it, we found that the Water in boiling is expanded 14000 times to generate a Steam as strong (*i. e.* elastick) as common Air, which therefore must be near  $16\frac{1}{2}$  times specifically lighter. And that this Steam is not made of the Air extracted out of the Water, is plain, because it is condensed again into Water, by a Jet of cold Water spouting in it; and the little quantity of Air that comes out of the injected Water must be discharged at every Stroke, otherwise the Engine will not work well: there is also one other Experiment to confirm this.

#### Experiment.

A, B, C, D is a pretty large Vessel of Water, which must be set on the Fire to boil: In this Vessel must be suspended the Glass Bell E, made heavy enough to sink in Water; but put in, in such a manner, that it be filled with Water when upright, without any Bubbles of Air at its Crown, within the Crown, being all under Water. As the Water boils, the Bell will, by Degrees, be emptied of its Water, being press'd down by the Steam which runs above the Water in the Bell; but as that Steam

hath the Appearance of Air, in order to know whether it be Air or not, take the Vessel off the Fire, draw up the Bell by a String fasten'd to its Knot at Top, 'till only the Mouth remains under Water; then, as the Steam condenses by the cold Air on the out-side of the Bell, the Water will rise up into the Bell at F, quite to the Top, without any Bubble above it; which shews that the Steam which kept out the Water was not Air.

N. B. This Experiment succeeds best when the Water has been first purg'd of Air by boiling and the Air-Pump. We know by several Experiments made on the Fire-Engine (in Captain Savery's Way, where the Steam is made to press immediately upon the Water) that Steam will drive away Air; and that in Proportion to its Heat, tho' in the open Air it floats and rises in it like Smoke.

Now if the Particles of Water turn'd into Steams or Vapour repel each other strongly, and repel Air more than they repel each other, Aggregates of such Particles made up of Vapour and Vacuity, may rise in Air of different Densities, according to their own Density dependant on their Degree of Heat, without having recourse to imaginary Bubbles, formed in a manner only supposed and not proved, as we have already shewn: *I own indeed, that if the watery Particles had no repellant Force, they must precipitate in the same manner that Dust will do after it has been raised up; but we have too many Observations and Experiments, to leave any doubt of the Existence of the repellant Force above-mentioned: neither can I shew how big the Molecules of Vapour must be which exclude Air from their Interstices, and whether these Molecules do vary in Proportion to the Degree of that Heat, by an increase of repellant Force in each watery Particle, or by a farther Division of the Particles into other Particles still less; but in general, we may reasonably affirm, that the Rarity of the Vapour is proportionable to the Degree of its Heat, as it happens in other Fluids (See Phil. Trans. N° 270) and that though the different Degrees of the Air's Rarification are also proportionable to the Heat, the same Degree of Heat rarifies Vapour much more than Air.*

Now, to shew that what hath been said will account for the Rise of Vapours and Formation of Clouds, we must only consider — whether that Degree of Heat which is known to rarify Water 14000 times, being compared with several of those Degrees of Heat in Summer, Autumn, and Winter, which are capable of raising Exhalations from Water or Ice; the Rarity of the Vapours (estimated by the Degree of Heat) will appear to be such, that the Vapour will rise high enough in Winter, and not too high in Summer, to agree with the known Phenomena.

That the Effects are adequate, to the Causes, in this Case I think I can make out in the following Manner; *viz.* The Heat of boiling Water, according to Sir Isaac Newton's Table (Phil. Trans. N° 270) is 34, the mean Heat of Summer 5, the mean Heat of Spring or Autumn 3, and the last Degree of Heat, at which Vapours rise in Winter (*alias* the mean Heat of Winter) is 2; the Rarity of Vapour proportionable to these four Degrees of Heat, is 14000, 2058, 1235, and 823. The Rarity of Air is, in Summer 900, in Spring or Autumn 850, and in Winter 800; the Density of Water compared with the abovementioned Densities, being inversely as one to the said forementioned four Numbers. The Heights above the Earth



to which the Vapours will rise, and at which they will be in *Æquilibrio* in an Air of the same Density with themselves, will vary according to the Rarity of the Vapour depending on the Heat of the Season. For Vapour, which is raised by the Winter's Heat, expressed by Number 2, when the Air's Rarity is 800, will rise to (and settle at) an Height of about the Sixth of a Mile, when the Barometer is above 30 Inches high. But if the Heat be greater, then the Vapours will rise higher, and pretty much higher if the Sun shines; tho' in frosty Weather the Barometer being then very high: If the Barometer falls, and therefore brings the Place of *Æquilibrio* (for Vapours raised by the Heat 2) nearer the Earth, then also will the Heat be increased, the Vapour more rarified, and consequently the new Place of *Æquilibrio* sufficiently high. It is to be observed, that in Winter, when the Heat is only equal to 2, the Air is densest close to the Earth, which has not any Heat sufficient to rarify it near to the Ground, as happens in warm Weather; therefore the Vapour will rise gradually in an Air where Density decreases continually from the Earth upwards; neither will the Vapour be hinder'd of its full Rise by any Condensation from a greater Cold of the ambient Air, the Air being then as cold next to the Ground where the Vapour begins to rise as it is at any Height from the Earth. The Vapour which is raised by the Heat of Spring or Autumn, express'd by Number 3, will rise to the Height of  $3\frac{1}{2}$  Miles, when the Barometer is at 30, and the Air's Rarity is 850. But then, as the Air is hotter nearer the Ground than at the Height of half a Mile or a Mile, then the Vapour will condense as it rises: and as the Air, when the Earth is heated, is rarer near the Ground than at some Height from it, the Place of *Æquilibrio* for Vapour will, upon these two Accounts, be brought much lower than otherways it would be; as for Example, to the Height of about a Mile, which will agree with the *Phænomena*.

In Summer, the two Causes above-mentioned increasing, the Vapour raised by the Heat 5 (whose Place of *Æquilibrio* would be  $5\frac{1}{2}$  Miles high, if the Vapour after it began to rise was not condensed by cooling, and the Air was denser close to the Earth) will settle at the Height of about  $1\frac{1}{2}$  or 2 Miles, which is also agreeable to the *Phænomena*.

Lastly, As the Density and Rarity of the Vapour is chiefly owing to its Degree of Heat, and in a small Measure to the increased or diminished Pressure of the circumambient Air, when it is not confined, and the Density and Rarity of the Air is chiefly owing to the increased or diminished Pressure, by the Accumulation or Exhaustion of the superior Air, whilst Heat and Cold alter its Density in a much less Proportion; the Clouds made of the Vapours above mentioned, instead of conforming themselves to the altered Density of the ambient Air, will rise when it is condensed, and sink when it is not rarified; and also rise or sink (when the Pressure of the Air is not altered, and its Density very little changed) by their own Dilatation, owing to Heat or Cold, as may be observed often by seeing them change their Height considerably, whilst the Barometer continues exactly at the same Degree, and the Thermometer's Liquor rises or falls very little, and sometimes none at all.

As for the Manner how Clouds are changed into Rain; I have hinted it in some of the preceding Pages; but for further Satisfaction I refer the Reader to Dr. Halley's Account, in his *Philosophical Transactions*, Numb. 183, in which I entirely acquiesce, having always found it agreeable to the *Phænomena*.

VADARI, in the *Civil Law*, signifies to pledge, undertake, or give Security in Behalf of another, that he shall on a certain Day appear in Court to prosecute or answer.

VADIMONIUM, in *Civil Law*, a Promise or Bond for Appearance before the Judge upon the Day appointed.

In VADO *exponere*, is to pawn, or leave any Equivalent as a Pledge or Surety of returning Money borrowed or owing.

VADIUM *Mortuum*, a Term in Law, signifying a Mortgage, Lands or immoveable Goods so pawn'd or engag'd to the Creditor, that he has a Right to the mean Profits for the Use of his Loan or Debt.

Per VADIUM *ponere*, in Law, signifies to take Security, Bail, or Pledges, for the Appearance of a Delinquent in some Court of Justice.

VAGINA, in *Architecture*, the lower Part of a Figure, called *Terminus*, because it resembles a Sheath out of which the Statue seems to issue, or it is that long Part between the Base and the Capital.

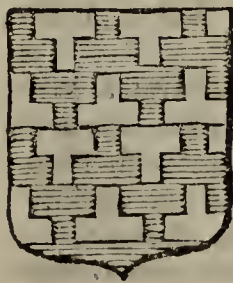
VAGINA, in *Anatomy*, a Canal or Cavity which leads from the *Pudendum* to the *Uterus* in Women.

VAGINA *Uteri*, } in *Anatomy*, a membra-  
VAGINA *Matricis*, } nous Part which reaches  
from the *Rima* or Aperture of the *Labia* to the Neck of the Womb.

VAGINALIS *Gulæ*, the perforated Muscle of the *Gula*, as *Willis* calls it; who says, The whole *Oesophagus* seems to consist of two Muscles, which make four Parallelograms with their opposite Fibres decussating each other: But in Men it is far otherwise; in whom the Fibres of this Muscle are Longitudinal and Oblique; the former seem to take their Original at the Arytenoidal Cartilages, and passing somewhat obliquely to the back Part of the *Oesophagus*, descend to the Stomach: The latter seems to be a Continuation of the *Pterigopharyngæus* and the *Oesophagus*, descending obliquely in a spiral Manner, not unlike those of the Intestines described by the learned Dr. Cole.

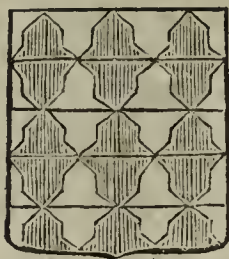
VAGUM, in *Anatomy*, the eighth Pair of Nerves of the *Medulla Oblongata*, usually called the *Par Vagus*, because dispers'd to divers Parts of the Body.

VAIRY, or VERRY, is when the Field of a Coat of Arms is chequered into 2 Colours by the Figures of little Bells; and if these Colours are Argent and Azure, 'tis *Vairy Proper*, and you need say no more than *Vairy*: But if the Colours are any other, they must be expressly named in Blazoning the Coat: See the Form of it under *Verry*.



VAIRY *Coppy*, or *Potent Counter-Potent*, is a Bearing in Heraldry of this Figure, and in Blazon, the Colours must be expressed; as *Azure* and *Argent*, &c.





*Contre-VAIRE*, is when the Metals and Colours are so ranged, that the Figure, which is *Azure*, touches either with its Edge or Foot another *Azure* Figure, being placed and joined together, Breech to Breech, one upon another, the Point of the one tending towards the Chief of the Escutcheon, and that of the other towards the Base; as in the Figure.

*VALORE Maritagii*, is a Writ: See *Value of Marriage*.

*VALETUDINARIANS*, *Valetudinarius*, L. a Person of a weak, crazy, sickly Constitution, frequently out of Order, &c.

*VALUE of Marriages*, or *Valore Maritagii*, is a Writ that lies for the Lord, having proffered covenable *Marriage* to the Infant, without Disparagement, if he refuse to take the Lord's Offer, to recover the *Value of the Marriage*: See *Stat. 12 Car. 2. cap. 24*.

*VALVE*, in *Hydraulicks*, *Pneumatics*, &c. a Kind of Lid or Cover of a Vessel or Tube so contriv'd as to open one Way, but the more forcibly it is pressed the other Way the closer it shuts its Aperture; so that it either admits the Entrance of a Fluid into the Vessel or Tube, and prevents its Return, or admits it to escape, and prevents its Re-entrance.

*VALVULA Major*, is the upper Part or Cover of the *Isthmus*, which is betwixt the *Testes* and the foremost Vermicular Process of the *Cerebellum*, to which two it is tied at its two Ends, and to the Processes that come from the *Cerebellum* to the *Testes* at its Sides. 'Tis of a Medullary Substance; its Use is to keep the *Lympha* from falling out above the Nerves in the Basis of the Skull.

*VALVES*, are little thin Membranes in Vessels or Fibres, like Folding-doors as it were; they have received different Names, according to the Diversity of their Figuration, as *Sigmoides*, like the Greek Letter *Sigma*; *Semilunares*, like an Half-Moon, &c. They are found in Veins, Arteries, and in the Lymphatick and Lacteal Vessels; nay, as some say, even in the Musculous Fibres. There are

*VALVES* also found in the Intestines, in the small and great Guts, especially in the *Jejunum*, and about the Beginning of the *Ilium*, which are called Semi-circular from their Figure. These Valves or Folds grow more and more Oblique by little and little, the nearer you come to the *Ilium*, and at the Beginning of the *Ilium*, they are less Oblique than further on.

In like manner, near the End of the *Jejunum*, they are gradually more and more distant from one another, and so in the *Ilium*.

At the Beginning, and in the Middle of the *Jejunum*, they are scarce distant half a Thumb's Breadth; in the *Ilium* a whole Thumb's Breadth, and more.

They yield a little if thrust with your Finger, and move here and there: At the Beginning of the *Colon* there is a fleshy and circular Valve, besides several others in that Gut.

The Use of them is to stop the Meat a little, that it may be the better fermented, the Chyle distributed, adjacent Parts be cherished with Heat; and lastly, that it ascends or returns not again.

*VALVULÆ Conniventes*: See *Conniventes*.

*VANE*. Those *Sights* which are made to move and slide upon *Cross-staves*, *Fore-staves*, *Davis's Quadrants*, &c. the Seamen call *Vanes*.

*VAN-GUARD*, a Military Term, signifying the first Line of an Army drawn up in Battalia. This is the same with the Front of an Army, and gives the first Charge upon the Enemy.

*VAPORARIUM*, is when the Patient sits so as that he receives the Vapours through an Hole, under which there is placed a Pot full of opposite and boiling hot Ingredients, which cooling, fresh Matter is added.

*VAPORATION*, in *Chymistry*, a Term applied to the Action of Vapour.

*VAPOROSUM Balneum*: See *Balneum Vaporis*.

*VAPOURS*, in a Medical Sense, is now-a-days used for the Disease called otherwise *Hysterick*, or *Hypochondriack Fits*, or *Melancholy*: But the most common Sense of the Word, is for watry Exhalations raised up either by the Heat of the Sun, the Subterranean, or any other accidental Heat, Fire, &c.

Mr. Halley, in *Philosophical Transactions*, N<sup>o</sup> 189. gives an Estimate of the Quantity of Vapours raised out of the Sea by the Warmth of the Sun, by an Experiment as follows.

We took a Pan (saith he) about 4 Inches deep, and 7 or 9 Inches in Diameter, in which we placed a Thermometer, and by means of a Pan of Coals, we brought the Water to the same Degree of Heat which is observed to be that of our Air in the hottest Summers; the Thermometer nicely shewing it.

Then we affixed the Pan of Water with the Thermometer in it to one End of the Beam of the Scales, and exactly counterpoised it with Weights in the other Scale: And by the Application or Removal of the Pan of Coals, we found it very easy to maintain the Water in the same precise Degree of Heat.

Doing thus, we found the Weight of the Water sensibly to decrease; and at the End of 2 Hours we observed, that there wanted half an Ounce of *Troy*, all but 7 Grains; or 233 Grains of Water, which in that Time had gone off in Vapour, tho' one could hardly perceive it to smoke, and the Water was not sensibly warm.

This Quantity in so short a Time, seemed very considerable, being little less than 6 Ounces in 24 Hours, from so small a Surface as a Circle of 8 Inches Diameter.

To reduce therefore this Experiment to an exact *Calculus*, and to determine the Thickness of that Skin of Water, which had so evaporated, I assume the Experiment alledged by Dr. Edward Bernard, to have been made in the *Oxford Society*, viz. That a Cube-Foot (*English*) of Water, weighs exactly 76 Pounds *Troy*. This divided by 1728, the Number of Inches in a Foot, will give  $253\frac{1}{3}$  Grains, or half an Ounce,  $13\frac{1}{3}$  Grains for the Weight of a Cube-Inch of Water; wherefore the Weight of 233 Grains is  $\frac{233}{253\frac{1}{3}}$ , or 35 Parts of 38 of a Cube-Inch of Water.

Now the Area of the Circle, whose Diameter is 72 Inches, is 49 Square Inches; by which dividing the Quantity of Water evaporated, viz.  $\frac{233}{253\frac{1}{3}}$  of an Inch, the Quote  $\frac{35}{38}$ , or  $\frac{1}{33}$ , shews that the Thickness of the Water evaporated, was the Fifty-third Part of an Inch; but we will suppose it only the Sixtieth Part, for the Facility of Calculation.

If therefore Water as warm as the Air in Summer, exhales the Thickness of a sixtieth Part of an Inch in two Hours, from its whole Surface, in



12 Hours it will exhale the  $\frac{1}{10}$  of an Inch ; which Quantity will be found abundantly sufficient to serve for all the Rains, Springs and Dews, and account for the *Caspian* Sea's being always at a Stand, neither waisting nor overflowing ; as likewise for the Current said to set always in at the Streights of *Gibraltar*, though those *Mediterranean* Seas receive so many and so considerable Rivers.

To estimate the Quantity of Water arising in Vapour out of the Sea, I think I ought to consider it only for the Time the Sun is up ; for that the Dews return in the Night, as much if not more Vapours than are then emitted ; and in Summer, the Days being longer than twelve Hours, this Excess is balanced by the weaker Action of the Sun, especially, when arising before the Water be warmed : So that if I allow  $\frac{1}{10}$  of an Inch of the Surface of the Sea, to be raised *per Diem* in Vapours, it may not be an improbable Conjecture.

Upon this Supposition every ten Square Inches of the Surface of the Water yields in Vapour *per Diem* a Cube-Inch of Water ; and each Square Foot half a Wine-pint ; every Space of four Foot Square, a Gallon ; a Mile Square, 6914 Tons ; a Square Degree, suppos'd of 69 *English* Miles, will evaporate 33 Millions of Tons : And if the *Mediterranean* be estimated at 40 Degrees long, and four broad, Allowances being made for the Places where it is broader by those where it is narrower (and I am sure I guess at the least) there will be 160 Square Degrees at Sea ; and consequently the whole *Mediterranean* must lose in Vapour in a Summer's Day at least 5280 Millions of Tons, and this Quantity of Vapour, though very great, is as little as the Remains of another Cause, which cannot be reduced to Rule, I mean the Winds ; whereby the Surface of the Water is lick'd up sometimes faster than it exhales by the Heat of the Sun ; as is well known to those that have considered those drying Winds which blow sometimes.

To estimate the Quantity of Water the *Mediterranean* Sea receives from the Rivers that fall into it, is a very hard Task, unless one had the Opportunity to measure their Channels and Velocity ; and therefore we can only do it by allowing more than enough : That is, by presuming these Rivers greater than in all Probability they be, and then comparing the Quantity of Water voided by the *Thames* with that of those Rivers whose Waters we desire to compute.

The *Mediterranean* receives these considerable Rivers, the *Iberus*, the *Rhone*, the *Tiber*, the *Po*, the *Danube*, the *Neister*, the *Borysthenes*, the *Tanais* and the *Nile* ; all the rest being of no great Note, and their Quantity of Water inconsiderable.

These nine Rivers we will suppose each of them to bring down ten times as much Water as the River of *Thames* ; not that any of them are so great in Reality, but to comprehend with them all the small Rivulets that fall into the Sea, which otherwise I know not how to allow for.

To calculate the Water of the *Thames*, I assume that at *Kingston-bridge*, where the Flood never reaches, and the Water always runs down ; the Breadth of the Channel is 100 Yards, and its Depth three, it being reduced to an Equality ; (in both which Suppositions I am sure I take with the most.)

Hence the Profile of the Water in this Place is 300 Square Yards : This multiplied by 48 Miles,

(which I allow the Water to run in 24 Hours, at two Miles an Hour) or 84480 Yards, gives 25344000 Cubick-Yards of Water to be evacuated every Day : That is 20300000 Tons *per Diem* : And I doubt not but in the Excess of my Measures of the Channel of the River, I have made more than sufficient Allowance for the Waters of the *Brent*, the *Wandel*, the *Lea*, and *Darwent*, which are all worth Notice, that fall into the *Thames* below *Kingston*.

Now if each of the aforesaid nine Rivers yield ten times as much Water as the *Thames* doth, 'twill follow, that each of them yield but 203 Millions of Tons *per Diem*, and the whole nine but 1827 Millions of Tons in a Day ; which is but little more than one Third of what is proved to be raised in Vapour out of the *Mediterranean* in Twelve Hours Time.

Now what becomes of this Vapour when raised, and how it comes to pass that the Current always sets in at the Mouth of the Streights of *Gibraltar*, is intended, with Leave, for a farther Entertainment of this Honourable Company.

In the mean Time, it is needful to advertise the Reader, That in making the Experiment herein mentioned, the Water used, had been salted to the same Degree as is the common Sea-Water, by the Solution of about a fortieth Part of Salt.

The Quantity of Vapours drawn by any determinate Heat from any Quantity of Water in a determinate Time, is always proportionable to the Surface of that Water : So that from the double Surface there will be raised a double Quantity of Vapour, from a triple Surface, a triple Quantity, &c.

For the Manner how, and the Reason why Vapours are raised by Heat, Mr. *Halley* gives the following Account.

He hath shewed, That if an Atom of Water be expanded into a Shell or Bubble, whose Diameter shall be ten times as great as before, such an Atom will be specifically lighter than Air, and will rise so long as that Flatus or warm Spirit, which first separated it from the Mass of Water, shall continue to distend it to the same Degree : But then that Warmth declining, and the Air growing cooler, and withal specifically lighter, these Vapours will stop at a certain Region of the Air, or else descend.

If therefore it should be supposed, That the whole Earth were covered with Water, and that the Sun, as now, should make his Diurnal Course round it, this learned Person thinks, That the Air would be impregnated with a certain Quantity of Aqueous Vapours, which it would retain in it like Salts dissolved in Water ; and that the Sun in the Day-time warming this Air, that Part of the Atmosphere would sustain a greater Proportion of Vapours ; (as warm Water will hold more Salt dissolved in it than cold) which, on the Absence of the Vapours at Night, would be discharged in Dews.

And in this Case he concludes, there could be no Diversity of Weather, other than periodically every Year alike, the Mixture of all Terrestrial, Saline, and Heterogeneous Vapours being here excluded, which he judges to be when variously compounded and driven by Winds, the Causes of those various Seasons and Changes of Weather which we now find.



But if instead of an Earth covered all over with Water, you suppose the Sea interspersed about wide and spacious Tracts of Land, and also divided by high Ridges of Mountains, such as the *Pyrenean*, the *Alps*, and the *Appenine* in *Europe*: *Taurus*, *Caucasus*, *Imaus*, &c. in *Asia*; Mount *Atlas*, and the *Mountains of the Moon* in *Africa*: And the *Andes* and *Apalatean* Mountains in *America*; each of which far surpasses the usual Height to which the Aqueous Vapours of themselves ascend, and on the Tops of which the Air is so cold and rarified, as to retain but a small Part of those Vapours which are brought thither by the Winds.

The Vapours therefore thus rais'd from the Sea, and by the Winds carried over the Low-Lands to those Ridges of Mountains, are there compelled by the Stream of the Air, to mount with it up to their Tops, where the Water presently precipitates, gleeing down by the Crannies of the Stones; and Part of the Vapour entering into the Caverns of the Hills, the Water thereof gathers as in an Alembick in the Basons of Stone which it finds; and these being once full, the Overplus of the Water runs down at the lowest Place of the Bason, and breaking out by the Sides of the Hills, forms *Single Springs*.

Many of which running down by the Valleys or Guts, between the Ridges of the Hills, and after uniting, form *little Rivulets* or *Brooks*; and many of these meeting again in a common Channel, form *large Rivers*.

And in this Theory, the Author saith, he was confirmed by Experience at *St. Helena*; where residing to make Celestial Observations, the Place being about 800 Yards above the Surface of the Sea, there was every Night such a Condensation, or rather Precipitation of the Vapours, as that, tho' the Sky was clear, they would cover every half Quarter of an Hour the Object-glasses of his Telescopes, and wet his Paper so that it would hardly bear Ink to write his Observations. *Philosophical Transactions*, N<sup>o</sup>. 192.

The Learned Dr. *Woodward* supposes the great Abyss of Water in the Bowels of the Earth to be the Promptuary from whence the Water of Springs and Rivers is chiefly deduced: See *Springs*.

Mr. *Homberg*, in some Experiments which he hath published in the *Memoires de Mathematique & de Physique*, for the Month of *May*, 1693. says, That the most probable Cause of the Elevation of Vapours in general, is that the Fiery or Æthereal Matter first puts the small Particles of the Water into an Agitation, and then mingles itself with it; which *Mixture* is what we call *Vapours*; this being specifically lighter than Air, will rise in it, 'till it come to such an Height, as that the Air is there of the same relative Gravity with itself, and there it will swim about, 'till by the Motion of Winds, or other Causes, its Constitution is broken, and so the watry Parts uniting together in greater Drops, it descends in Dew, or Rain: Which Notion differs very little from Mr. *Halley's*. Only *Homberg*, by an Experiment which he made of Evaporation in Vacuo, concludes, that Air is not necessary to the first rising of Vapours, but only to the making of them mount up on high, after they once are brought or raised into it.

VARI, with *Physicians*, little, hard, ruddy Tumours, whitish about the Tips, and about the Size

of an Hemp-feed, frequently appearing on the Face and Neck of young People, and chiefly such as are much addicted to Venerie.

VARIABLE QUANTITIES, in Fluxions, are such as are supposed to be continually increasing or decreasing; and so do, by the Motion of their said Increase or Decrease, generate Lines, Area's or Solidities.

VARIANCE, in Law, an Alteration or Change of Condition in a Person or Thing, after some Concern or Transaction therewith.

VARIATION, or Permutation of Quantities; is the changing any Number of given Quantities, with respect to their Places. See *Combination*.

VARIATION is, according to *Tycho*, the third Inequality in the Motion of the Moon; and arises from her *Apogæum*, being changed as her System is carried round the Sun by the Earth. *Bullialdus* calls this the Moon's *Reflexion*, expressing it, That her *Apogæon* reflects backwards contrary to the Order or Succession of the Signs, by reason of which the Angle of her *Evection* is sometimes more, and sometimes less than it would appear to be, by considering only the two other Inequalities. But *Tycho* asserts this *Variation* to be never less than 40 Minutes, 30 Seconds.

Sir *Isaac Newton* thinks the *Variation* is caused partly by the Elliptick Form of the Moon's Orbit, and partly by the Inequality of the Moments of the Area which the Moon describes by a Radius drawn to the Earth. This, *Prop. 29. Book 3.* of his *Principia*, he shews how to find; and sets it at a middle Rate, to be 35 Minutes, 9 Seconds.

VARIATION of the Needle and Compass, is the Deviation, or Turning of the *Magnetical Needle*, in the *Mariners Compass*, from the true North-point; which happens more or less in most Places; and is commonly called by Sea-men the *North-Easting*, or *North-Westing* of the Needle.

#### To find the Variation at Sea.

About three Hours before or after Noon, having the *Sun's Declination*, his *Altitude*, and the Latitude of the Place, find his true *Azimuth* (as is directed under the Word) observe also the *Sun's Magnetical Azimuth*, and then the Differences of those two Distances from the *Meridian* is the *Variation of the Compass*.

The same is also found by having the *Sun's True* and *Magnetical Amplitude*.

For if the Amplitudes be of one kind, that is, both North, or both South, their Difference is the *Variation*: But if of different kinds, that is one North, the other South, their Sum is the *Variation*.

In the Practice of observing the Variation, it is as usual to take it by the Amplitude of the Rising and Setting of the Sun, when his Centre appears in the visible Horizon; whereas he ought to be observed when his under Limb is still above the Horizon about two Thirds of his Diameter, or 20 Minutes, because of the Refraction, and the Height of the Observer's Eye above the Surface of the Water; or else to work the Amplitudes, as the Azimuths, by reckoning the Sun's Distance from the Zenith 90 Degrees 36 Minutes. This, tho' it be of little Consequence near the Equinoctial, will make a great Error in high Latitudes, where the Sun Rises and Sets obliquely.

A Table



*A Table of the Variation of the Compass, as it hath been observed in divers Places, and at divers Times.*

| Names of Places.                              | Longitude from London. |      | Latitude. | Anno Dom. | Variation observed. |      |
|---|------------------------|------|-----------|-----------|---------------------|------|
|   | Deg.                   | Min. | De. Min.  |           | Deg.                | Min. |
| London,                                       | 00                     | 00   | 51 32 N   | 1580      | 11 15               | E    |
|   |                        |      |           | 1622      | 6 00                | E    |
|   |                        |      |           | 1634      | 4 5                 | E    |
|   |                        |      |           | 1672      | 2 30                | W    |
|   |                        |      |           | 1683      | 4 30                | W    |
| Paris,  | 2                      | 25 E | 48 51 N   | 1640      | 3 00                | E    |
|   |                        |      |           | 1666      | 0 0                 |      |
|   |                        |      |           | 1681      | 2 30                | W    |
| Uraniburg,                                    | 13                     | 00 E | 55 54 N   | 1672      | 2 35                | W    |
| Copenhagen,                                   | 12                     | 53 E | 55 41 N   | 1649      | 1 30                | E    |
| Dantzick,                                     | 19                     | 0 E  | 54 23 N   | 1679      | 7 00                | W    |
| Mompelier,                                    | 4                      | 0 E  | 43 37 N   | 1574      | 1 10                | W    |
| Brest,  | 4                      | 25 W | 48 23 N   | 1680      | 1 45                | W    |
| Rome,   | 13                     | 0 E  | 41 50 N   | 1681      | 5 0                 | W    |
| Bayonne,                                      | 1                      | 20 W | 43 33 N   | 1680      | 1 20                | W    |
| Hudson's-Bay,                                 | 79                     | 40 W | 51 00 N   | 1668      | 19 15               | W    |
| Hudson's-Streights,                           | 57                     | 00 W | 61 00 N   | 1668      | 29 30               | W    |
| In Baffin's-Bay, at Sir Thomas Smith's Sound, | 80                     | 0 W  | 78 00 N   | 1616      | 57 00               | W    |
| At Sea,                                       | 50                     | 0 W  | 38 40 N   | 1682      | 7 30                | W    |
| At Sea,                                       | 31                     | 30 W | 43 50 N   | 1682      | 5 30                | W    |
| At Sea,                                       | 42                     | 00 W | 21 0 N    | 1678      | 0 40                | E    |
| Cape St. Augustine,                           | 35                     | 30 W | 8 0 S     | 1670      | 5 10                | E    |
| At Sea off the Mouth of R. Plata,             | 58                     | 0 W  | 39 30 S   | 1670      | 20 30               | E    |
| Cape Frio,                                    | 41                     | 10 W | 22 40 S   | 1670      | 12 10               | E    |
| At the East Entrance of Magellan-Streights,   | 68                     | 0 W  | 52 30 S   | 1670      | 17 00               | E    |
| At the West Entrance of Magellan-Streights,   | 75                     | 0 W  | 53 0 S    | 1670      | 14 10               | E    |
| Baldivia,                                     | 73                     | 0 W  | 40 0 S    | 1670      | 8 10                | E    |
| Cape Augulhas,                                | 16                     | 30 E | 34 50 S   | 1622      | 2 0                 | W    |
|   |                        |      |           | 1675      | 8 0                 | W    |
| At Sea,                                       | 1                      | 00 E | 34 30 S   | 1675      | 0 0                 |      |
| At Sea,                                       | 20                     | 0 W  | 34 0 S    | 1675      | 10 30               | E    |
| At Sea,                                       | 32                     | 0 W  | 24 0 S    | 1675      | 10 30               | E    |
| St. Helena,                                   | 6                      | 30 W | 16 0 S    | 1677      | 0 40                | E    |
| J. Ascension,                                 | 14                     | 10 W | 7 50 S    | 1678      | 1 0                 | E    |
| Johanna,                                      | 44                     | 00 E | 12 15 S   | 1675      | 19 30               | W    |
| Monbasa,                                      | 40                     | 00 E | 4 0 S     | 1675      | 16 0                | W    |
| Zocatra,                                      | 56                     | 0 E  | 12 30 N   | 1674      | 17 0                | W    |
| Aden, at the Mouth of the Red-Sea,            | 47                     | 30 E | 31 00 N   | 1674      | 15 0                | W    |
| Diego Roiz,                                   | 61                     | 0 E  | 20 0 S    | 1676      | 20 30               | W    |
| At Sea,                                       | 64                     | 30 E | 0 0       | 1676      | 15 30               | W    |
| At Sea,                                       | 54                     | 0 E  | 27 0 S    | 1676      | 24 0                | W    |
| Bombay,                                       | 72                     | 30 E | 19 0 N    | 1676      | 12 0                | W    |
| G. Comorin,                                   | 76                     | 0 E  | 8 15 N    | 1680      | 8 48                | W    |
| Ballafore,                                    | 87                     | 0 E  | 21 30 N   | 1680      | 8 20                | W    |
| Fort St. George,                              | 180                    | 0 E  | 13 15 N   | 1680      | 8 10                | W    |
| West Point of Java,                           | 104                    | 0 E  | 6 40 S    | 1676      | 3 10                | W    |
| At Sea,                                       | 58                     | 0 E  | 39 0 S    | 1677      | 27 30               | W    |
| J. St. Paul,                                  | 72                     | 0 E  | 38 0 S    | 1677      | 23 30               | W    |
| At Van Diemens,                               | 142                    | 0 E  | 42 25 S   | 1642      | 0 0                 |      |
| At New Zealand,                               | 170                    | 0 E  | 40 50 S   | 1642      | 9 0                 | E    |
| At Three King Isle in New-Zealand,            | 169                    | 30 E | 34 35 S   | 1642      | 8 40                | E    |
| J. Rotterdam in the South-Sea,                | 184                    | 0 E  | 20 15 S   | 1642      | 6 20                | E    |
| On the Coast of New-Guinea,                   | 149                    | 0 E  | 4 30 S    | 1643      | 8 45                | E    |
| At the West Point of New-Guinea,              | 126                    | 0 E  | 0 26 S    | 1643      | 5 30                | E    |



From the foregoing Table 'tis observed by the Learned  
Capt. Halley,

1. That in all *Europe*, the *Variation* at this Time is *West*, and more in the Eastern Parts thereof than the Western, increasing that way.

2. That on the Coast of *America*, about *Virginia*, *New-England*, and *Newfoundland*, the *Variation* is *Westerly*, increasing all the way as you go Northerly along the Coast, so as to be above 20 Degrees at *Newfoundland*, nearly 30 Degrees in *Hudson's-Streights*, and not less than 57 Degrees in *Baffin's-Bay*: And that as you sail Eastward from this Coast the *Variation* diminishes.

Whence it is, That somewhere between *Europe* and the North Part of *America*, there must be an Easterly *Variation*, or at no *Variation*.

3. That on the Coast of *Brazil*, there is East *Variation*, increasing as you go to the Southward, so as to be 12 Degrees at *Cape Frio*, and 20 Degr. and half over-against *R. Plata*; and thence sailing South-westerly to the *Streights of Magellan*, it decreases 17 Degrees, and at the West Entrance about 14 Degrees.

4. That to the Eastward of *Brazil*, this Easterly *Variation* decreases, so as to be very little at *St. Helena* and *Ascension*, and to be quite gone, and the Compass Point true about 18 Degrees of Longitude West from the *Cape of Good Hope*.

5. That to the Eastward of the aforesaid Places, a Westward *Variation* begins, and governs in all the *Indian Sea*, arising to 18 Degrees under the Equator, about the Meridian of the Northern Part of *Madagascar*; and 27 Degrees and a half in 39 Degrees South Latitude, near the same Meridian: Easterly from thence, the West *Variation* decreases, so as to be not much above 8 Degrees at *Cape Comorin*, and about 3 Degrees upon the Coast of *Java*; and about the *Molucca Islands* to be quite gone; as also a little to the Westward of *Van Diemen's Land*.

6. That to the Eastward of the *Molucca's* and *Van Diemen's Land*, in South Latitude, there arises another Easterly *Variation*, which seems not so great as the former, nor of so large Extent; for that at the Island *Rotterdam*, it is sensibly less than upon the East Coast of *New Guinea*; and at the Rate it decreases, it may well be supposed, that about 20 Degrees further Eastward, or 225 Degrees East Longitude from *London*, in the Latitude of 20 Degrees South, a *Westerly Wind* begins.

7. That the *Variation* taken at *Baldivia*, and at the West Entrance of the *Streights of Magellan*, shews, That the East *Variation*, noted in the third Observation, is decreasing a-pace; and that it cannot well extend many Degrees into the *South Sea*, from the Coast of *Peru* and *Chili*, leaving Room for a small *Westerly Variation* in that Tract of the unknown World that lies in the mid-way between *Chili* and *New Zealand*, and between *Hounds Island* and *Peru*.

8. That in sailing North-west from *St. Helena* by *Ascension*, as far as the Equator, the *Variation*

continues very small Easterly, and as it were, constantly the same; so that in this Part of the World, the Course, wherein there is no *Variation*, is evidently no Meridian, but rather North-west.

9. That the Entrance of *Hudson's-Streights*, and the Mouth of *R. Plata*, being nearly under the same Meridian, at the one Place the Needle varies 29 Degrees and a half West; at the other 20 Degrees and a half East.

Whence 'tis concluded,

That the whole Globe of the Earth is one great Magnet, having four Magnetical Poles, or Points of Attraction, near each Pole of the Equator two; and that in those Parts of the World which lie near adjacent to any one of those Magnetical Poles, the Needle is govern'd thereby, the nearest Pole being always predominant over the more remote.

And he conjectures, That the Pole, which is at present nearest to us, lies in or near the Meridian of the *Land's-End of England*, and not above 7 Degrees from the *Arctic Pole*; by this Pole the *Variations* in all *Europe* and *Tartary*, and the *North Sea*, are principally govern'd; tho' with regard to the other *Northern Poles*, whose Situation is in the Meridian passing about the Middle of *California*, and about 15 Degrees from the North Pole of the World; to this the Needle has chiefly respect in all the *North America*, and in the two Oceans on either Side thereof, from the *Azores* Westwards to *Japan*, and farther.

The two Southern Poles are rather farther distant from the South Pole of the World: The one about 16 Degrees therefrom, in a Meridian some 20 Degr. to the Westward of *Magellan's Streights*, or 95 Degrees West from *London*; this commands the Needle in all *South America*, in the *Pacifick Sea*, and the greatest Part of the *Ethiopic Ocean*.

The fourth and last Pole seems to have the greatest Power, and largest Dominions of all, as it is the most remote from the Pole of the World, being little less than 20 Degrees distant therefrom, in the Meridian which passes through *New Holland* and the Island *Celebes* about 120 Degrees East from *London*; this Pole is predominant in the South Part of *Africa*, in *Arabia*, and the *Red Sea*, in *Persia*, *India*, and its Islands; and all over the *Indian Sea*, from the *Cape of Good Hope* Eastwards, to the middle of the great South Sea that divides *Asia* from *America*.

This seems to be the present Disposition of the Magnetical Vertue throughout the whole Globe of the Earth: It remains to shew how this Hypothesis makes out all the *Variations* that have been observ'd of late; and how it answers to the several Remarks drawn from the Table.

And first, it is plain that (our *European North Pole* being in the Meridian of the *Lands-end of England*) all Places more Easterly than that, will have it on the West-side of their Meridian; and consequently the Needle respecting it with its Northern Point, will have a *Westerly Variation*, which will still be greater as you go to the Eastwards, till you come to some Meridian of *Russia*, where 'twill be greatest, and from thence decrease again. Thus at *Brest* the *Variation* being but 1 Degree and



3 Quarters at *London* 4 Degrees and a half; but at *Dantzick* 7 Degrees West. To the Westward of the Meridian, of the *Land's-End* the Needle ought to have an Easterly Variation; were it not that (by approaching the *American Northern Pole*, which lies on the West-side of the Meridian, and seems to be of greater force than this other) the Needle is drawn thereby Westward, so as to counter-balance the Direction given by the *European Pole*, and to make a small West Variation in the Meridian of the *Land's-End* itself. Yet about the Meridian of the *Isle Tercera*, 'tis supposed our nearest Pole may so far prevail, as to give the Needle a little Turn to the East, tho' but for a very little Space, the Counter-balance of those two Poles permitting no considerable Variation in all the Eastern part of the *Atlantick Ocean*, nor upon the West Coast of *England* and *Ireland*, *France*, *Spain*, and *Barbary*: But to the Westward of the *Azores*, the Power of the *American Pole* overcoming that of the *European*, the Needle has chiefly respect thereto; and turns still more and more towards it, as you approach it. Whence it comes to pass, that on the Coast of *Virginia*, *New-England*, *Newfoundland*, and in *Hudson's-Streights*, the Variation is Westward; that it increases as you go from thence towards *Europe*, and that it is less in *Virginia* and *New-England*, than in *Newfoundland* and *Hudson's-Streights*.

This Westerly Variation again decreases as you pass over the *North America*; and about the Meridian of the middle of *California*, the Needle again points due North; and from thence Westward to *Yedzo* and *Japan*, 'tis supposed the Variation is Easterly, and half Sea over, not less than 15 Degrees: And that this East Variation extends over *Japan*, *Yedzo*, *East-Tartary*, and part of *China*, 'till it meet with the Westerly, which is governed by the *European North Pole*, and which is the greatest somewhere in *Russia*.

Towards the South Pole the Effect is much the same, only that here the South Point of the Needle is attracted.

Hence it will follow, That the Variation on the Coast of *Brazil*, at the River of *Plate*, and so on to the *Streights* of *Magellan*, should be Easterly, if we suppose a Magnetical Pole situated about 20 Degrees more Westerly than the *Streights* of *Magellan*. And this Easterly Variation doth extend Eastward over the greatest part of the *Ethiopic* Sea, 'till it be counterpoiz'd by the Virtue of the other Southern Pole; as it is about mid-way between the *Cape of Good Hope* and the *Isles* of *Tristan d'Acuntia*.

From thence Eastwards the *Asian South Pole* becoming prevalent, and the South Point of the Needle being attracted thereby, there arises a West Variation very great in Quantity and Extent, because of the great Distance of this Magnetical Pole of the World.

Hence it is, that all the *Indian Sea*, as far as *Hollandia Nova*, and farther, there is constantly West Variation; and that under the Equator itself, it arises to no less than 18 Degrees, where 'tis most.

About the Meridian of the Island of *Celebes*, being likewise that of this Pole, this Westerly Variation ceases, and an Easterly begins, which reaches to the middle of the South Sea, between the middle of *Zelandia Nova* and *Chili*, leaving room for a

small West Variation governed by the *American South Pole*.

From all this it appears, That the Direction of the Needle in the Temperate and the Frigid Zone, depends chiefly upon the Counterpoise of the Forces of two Magnetical Poles of the same Nature: As also how it is, that under the same Meridian the Variation should be in one place 29 Degrees and a half West, and in another 20 Degrees and a half East.

In the *Torrid Zone*, and particularly under the Equinoctial, respect must be had to all four Poles; and their Positions well consider'd; otherwise it will not be easy to determine what Variations shall be, the nearest Pole being always strongest; yet not so as not to be counter-balanced sometimes by the united Forces of two more remote; as is noted in the eighth Observation, that in sailing from *St. Helena*, by the *Isle* of *Ascension*, to the Equator, on the North-west Course, the Variation is very little Easterly, and in that whole Tract unalterable, because that the *South American Pole* (which is considerably the nearest in the aforesaid Places) requiring a great Easterly Variation, is counterpoiz'd by the contrary Attraction of the *North American*, and the *Asian South Pole*; each whereof singly are, in these Parts, weaker than the *American South Pole*; and upon the North-west Course, the Distance from this latter is very little varied; and as you recede from the *Asian South Pole*, the Balance is still preserv'd by access towards the *North American Pole*. In this Case no notice is taken of the *European North Pole*; its Meridian being little removed from those of these Places, and of itself requiring the same Variations we here find.

After the same manner you may proceed to determine the Variations in other places, under and near the Equator.

All this seems very much to confirm the aforesaid Hypothesis, That there are in the Earth four such Magnetical Points, or Poles, which occasion the great Variety, and seeming Irregularity, which is observed in the Variation of the Compass.

But to calculate exactly what it is, in any Place assigned, is not as yet done, nor is it determined in what Proportion the attractive Power decreases, as you remove from the Pole of the Magnet; as also the Change of the Variation, and at what Rate, is not yet perfectly discovered.

From the foregoing Table, it should seem, that all the Magnetical Poles had a Motion Westward; but if it be so, 'tis evident, that it is not a Rotation about the Axis of the Earth; for then the Variations would continue the same, in the same Parallel of Latitude (the Longitude only changed) as much as the Motion of the Magnetical Poles: But the contrary is found by Experience; for there is no where in the Latitude of 51 and an half North, between *England* and *America*, a Variation of 11 Degrees East, at this Time; as it was once here at *London*. Wherefore it seems that our *European Pole* is grown nearer the Pole *Arctic* than it was heretofore; or else that it has lost part of its Virtue.

But whether these Magnetick Poles move altogether with one Motion, or with several, whether equally, or unequally; whether circular, or libratory: If circular, about what Centre; if libratory, after what manner, are things yet unknown.



In *Philos. Transf.* N°. 195. Capt. *Halley* brings the following *Hypothesis*, accounting for this *Variation*, and solving all its *Phænomenas*; which is thus:

He reckons the external Parts of the Globe as the Shell, and the internal as a *Nucleus*, or inner Globe, included within ours, with a fluid Medium between, which having the same common Centre and Axis of Diurnal Rotation, may turn about with our Earth each 24 Hours; only this outer Sphere having its turbinating Motion, some small Matter either swifter or slower than the internal Ball. And a very minute Difference in Length of Time, by many Repetitions, becomes sensible; the internal Parts will by degrees recede from the external; and not keeping pace with one another, will appear gradually to move, either Eastward or Westward, by the Difference of their Motions.

Now supposing such an internal Sphere having such a Motion, the two great Difficulties in the former Hypothesis is easily solv'd: For if this exterior Shell of Earth be a Magnet, having its Poles at a distance from the Poles of Diurnal Rotation; and if the internal *Nucleus* be likewise a Magnet, having its Poles in two other Places distant also from the Axis; and these latter, by a gradual and slow Motion, change their Place in respect of the External; we may then give a reasonable Account of the four Magnetical Poles aforementioned, as likewise of the Changes of the Needle's Variations.

The Period of this Motion being wonderful great, and there being hardly an hundred Years since these Variations have been duly observ'd, it will be very hard to bring this *Hypothesis* to a *Calculus*, especially since, tho' the Variations do increase and decrease regularly in the same Place, yet in differing Places, at no great Distance, there are found such casual Changes thereof, as can no ways be accounted for by a regular Hypothesis, as depending upon the unequal and irregular Distribution of the Magnetical Matter within the Substance of the external Shell or Coat of the Earth, which deflect the Needle from the Position it would acquire from the Effect of the general Magnetism of the whole.

Of this, the *Variations* at *London* and *Paris* give a notable Instance; for the Needle has been constantly about  $1\frac{1}{2}$  more Easterly at *Paris* than at *London*: Tho' it be certain, that according to the general Effect, the Difference ought to be contrary way; notwithstanding which, the Variations in both Places do change alike.

Hence, and from some other Things of like Nature, it seems plain, that the two Poles of the external Globe are fix'd in the Earth, and that if the Needle were wholly govern'd by them, the *Variations* thereof would be always the same, with some Irregularities upon the Account but just now mention'd. But the internal Sphere having such a gradual Translation of its Poles, does influence the Needle, and direct it variously, according to the Result of the attractive or directive Power of each Pole; and, consequently, there must be a Period of the Revolution of this internal Ball; after which, the Variations will return again as before. But if it shall in future Ages be observed otherwise, we must then conclude, that there are more of these internal Spheres, and more Magnetical Poles

than Four, which, at present, we have not a sufficient Number of Observations to determine, and particularly in that vast *Mer del Zur*, which occupies so great a Part of the whole Surface of the Earth.

If then two of the Poles be fix'd, and two moveable, it remains to ascertain which they are that keep their Place. And it were to be wish'd we had the the Experience of another Century of Years to found our Conclusions upon: Yet he thinks it may be safely determined, that our *European North Pole* (which is supposed to be near the Meridian of the *Land's-End* of *England*, and about 7 Deg. therefrom) is that that is moveable of the two Northern Poles, and that that has chiefly influenced the Variations in these Parts of the World: For in *Hudson's-Bay*, which is under the Direction of the *American Pole*, the Change is not observ'd to be near so fast as in these Parts of *Europe*, tho' that Pole be much farther removed from the Axis.

As to the *South Poles*, he takes the *Asian Pole*, which he places about the Meridian of the Island *Celebes* to be fixed, and consequently the *American Pole* to move, from the like Observation of the slow Decrease of the Variation on the Coast of *Java*, and near the Meridian of the *Asian Pole*; tho' he owns to have no Account of the Effects of the the other beyond *Magellan Straights*.

This being granted, 'tis plain, that the fixed Poles are the Poles of this external Shell or *Cortex* of the Earth; and the other two the Poles of the Magnetical *Nucleus*, included and moveable within the other. It likewise follows, that this Motion is Westwards; and, by Consequence, that the aforesaid *Nucleus* has not precisely attain'd the same Degree of Velocity with the exterior Parts in their diurnal Revolutions; but so very nearly equals it, that in 365 Revolves, the Difference is scarce sensible.

This is supposed to arise from the Impulse whereby this diurnal Motion was impress'd on the Earth, being given to the external Parts, and from thence, in time, communicated to the internal; but not so, as perfectly to equal the Velocity of the first Motion impress'd on, and still conserv'd by the superficial Parts of the Globe.

As to the Quantity of this Motion, it is impossible to define it, both from the Nature of this kind of Observation, which cannot be very accurately perform'd; as also, from the small Time these Variations have been observ'd, and their Change discover'd. It appears by all Circumstances, that its Period is of many Centuries of Years, and as far as may be collected from the Change of the Place, where there was no Variation, by reason of the *Equilibrium* of the two Southern Magnetical Poles, viz. from *Cape d' Agulhas*, to the Meridian of *St. Helena* (which is about 23 Deg. in about 90 Years) and of the Place where the Westerly Variation is in its greatest Deflection, being about half so much, viz. from the Isle of *Diego Roiz*, to the South-west Parts of *Madagascar*; we may with some Reason conjecture, that the *American Pole* has moved Westward 46 Deg. in that Time, and that the whole Period thereof is perform'd in 700 Years, or thereabouts: So that the nice Determination of this, and of several other Particulars in the Magnetick System, is reserv'd for Posterity; all that we can hope to do, is to leave behind us Observations that may be confided in, and to propose Hypotheses



potheses which After-ages may examine, amend, and refute.

Thus, in order to explain the Change of the *Variations*, we have adventured to make the Earth hollow, and to place another Globe within it; not but that there may be several Objections against it; as,

That there is no Instance in Nature of the like Thing.

That if there was such a middle Globe, it would not keep its Place in the Centre, but be apt to deviate therefrom, and might possibly chock against the concave Shell, to the Ruin, or at least Endamaging thereof.

That the Water of the Sea would perpetually leak through, unless we suppose the Cavity to be full of Water.

That were it possible, yet it does not appear what Use such an inward Sphere can be of, being shut up in eternal Darkness, and therefore unfit for the Production of Animals, or Plants; with many more Objections, according to the Fate of all such new Propositions.

To these it may be briefly answer'd, That the Ring environing the Globe of *Saturn*, is a notable Instance of this kind, as having the same common Centre, and moving along with the Planet, without sensibly approaching him on one side more than on the other. And if this Ring were turned on one of its Diameters, it would then describe such a concave Sphere as this external one is supposed to be. And since the Ring in any Position given, would in the same manner keep the Centre of *Saturn* in its own, it follows, That such a concave Sphere may move with another included in it, having the same common Centre: Nor can it well be supposed otherwise, considering the Nature of Gravity; for should these Globes be adjusted once to the same common Centre, the Gravity of the Parts of the Concave would press equally towards the Centre of the inner Ball; which Equality must necessarily continue till some external Force disturb it, which is not easy to imagine in this Case. And perhaps, this might be more intelligibly express'd, by saying, That the inner Globe being posited in the Centre of the Exterior, must necessarily ascend which way soever it moves; that is, it must overcome the Force of Gravity pressing towards the common Centre, by an Impulse it must receive from some outward Agent. But all outward Efforts being sufficiently fenced against, by the Shell that surrounds it, it follows, that this *Nucleus*, being once fix'd in the common Centre, must always there remain.

As to the Leaking of the Water through this Shell, when once a Passage shall be found for it to run through, is confess'd to be an Objection seemingly of Weight; but by considering how rightly great Beds of Chalk or Clay, and much more Stone, do hold Water, and even Caves arch'd with Sand, no Man can doubt but the Wisdom of the Creator has provided for the Microcosm, by many more Ways than can be either imagin'd or express'd; especially since we see the admirable and innumerable Contrivances wherewith each worthless Individual is furnish'd, both to defend it self, and pro-

pagate its Species. What Curiosity in the Structure; what Accuracy in the Mixture and Composition of the Parts ought not we to expect in the Fabrick of this Globe, made to be the lasting Habitation of so many various Species of Animals, in each of which, there want not many Instances that manifest the boundless Power and Goodness of their Divine Author; and can we then think it a hard Supposition, that the internal Parts of this Bubble of Earth should be replete with such *Saline* and *Vitriolick* Particles, as may contribute to Petrefaction, and dispose the transfusing Water to shoot and coagulate into Stone, so as continually to fortify, and, if need were, to consolidate any Breach or Flaw in the concave Surface of the Shell.

And perhaps this may not without reason be supposed to be the final Cause of the Admixture of the magnetical Matter in the Mass of the terrestrial Parts of our Globe, *viz.* To make good and maintain the concave Arch of this Shell: For, by what the excellent Sir *Is. Newton* has shewn in his *Principia Philosophiæ*, it will follow, that according to the general Principle of Gravity, visible throughout the whole Universe, of those Particles that by Length of Time, or otherwise, shall moulder away, or become loose on the concave Surface of the external Sphere, would fall in, and with great Force descend on the internal, unless those Particles were of another sort of Matter, capable by their stronger Tendency to each other, to suspend the Force of Gravity; but no other Substance is known capable of supporting each other by their mutual Attraction, but the Magnetical; and these we see miraculously to perform that Office, even where the Power of Gravity has its full Effect; much more within the Globe, where it is weaker. Why then may we not suppose these said Arches to be lined throughout with a magnetical Matter, or rather, to be one great concave Magnet, whose two Poles are the Poles we have before observ'd to be fix'd in the Surface of our Globe.

Another Argument favouring this Hypothesis, is drawn from a Proposition of the same Sir *Isaac Newton*, where he determines the Force wherewith the *Moon* moves the *Sea* in producing the *Tides*; his Words are, *Densitas Lunæ est ad densitatem Terræ ut 680 ad 387, seu 9 ad 5 quam proxime. Est igitur Corpus Lunæ densius ac magis terrestre quam Terra nostra*, p. 466.

Now if the *Moon* be more solid than the Earth, as 9 to 5, why may we not reasonably suppose the *Moon*, being a small Body, and a secondary Planet, to be solid Earth, Water and Stone, and this Globe to consist of the same Materials, only  $\frac{4}{5}$  thereof to be Cavity, within and between the internal Spheres, which might be rendred not improbable.

And one of the Uses of the Cavity of the Earth seems to be, to diminish the Specifick Gravity thereof, in respect of the *Moon*; for it may be demonstrated, that the Opposition of the *Æther* to the Motions of the Planets, in a long time, becomes sensible; and consequently, the greater Bodies must receive a less Opposition than the smaller, unless the Specifick Gravity of the smaller do proportionably exceed that of the greater, in which Case only they can move together; so that the Cavity assign'd in the Earth, may serve well to adjust its Weight to that of the *Moon*: For otherwise, the Earth would leave the *Moon* behind it, and she become another primary Planet.



**VARIATION** of the *Moon*, in *Astronomy*, is the third Inequality observed in her Motion, whereby when she is out of her Quadratures, her true Place differs from her Place twice equated: It is also called the Reflexion of her Light.

**VARIATION**, in *Musick*, is the different Manners of playing or singing a Tune or Song; whether by subdividing the Notes into several others of lesser Value, or by adding Graces, &c. But yet after such a Manner, that the Ground of the Tune may be discerned through all the Inrichments.

**VARICIFORMES** *Parastatae*, in *Anatomy*, two Vessels near the Bladder, so called by reason of their many Turnings, which serve to work the Seed the better.

**VARICOSUM** *Corpus*, is that Contexture of Spermatick Vessels, which enters the Testicles.

**VARIOLÆ**, the *Small-Pox*, consists in a contagious Disorder of the Blood, contracted from the Air or otherwise; accompanied with a continued wandring Fever, which sometimes increases, sometimes decreases, with a Pain in the Head and Loins, Anxiety and Inquietude, and with a breaking forth of Pimples and Wheals, which swell and suppurate. The Famous *Willis* attributes the Cause of this Distemper to some filthy and fermentative Matter, which is communicated to the *Fœtus*, together with the Nourishment from the Womb; but how this can hold in adult Persons, whose Blood has undergone so many Alterations, I could never yet understand from his Writings. It seems rather to consist in a depraved Temperature of Air, with a peculiar Disposition of the Blood and the nervous Juice towards this Distemper. This poisonous Quality of the Air, first infects the nervous Juice (whence proceeds the Pain of the Head and Loins) wherewith the Blood boils and ferments, and parts into little Pieces or Clots, which in the Course of Circulation, stick to the outward Parts, and to the inner *Viscera* too; after a while they grow ripe, and suppurate. *Blanchard*.

**VARIX**: See *Cirrus*.

**VAS breve**: See *Breve vas*.

**VASA**, the *Vessels in an Animal*, are Cavities through which the Liquors of the Body pass, as a Vein, an Artery, Lymphatick Vessels, the *Ductus* that conveys the Chyle, and those of the Spittle.

**VASA Concordiæ**, in *Hydraulick Authors*, are two Vessels so constructed, that one of them, tho' full of Wine, will not run a Drop, except the other, being full of Water, do run also.

**VASA Deferentia**, are those Vessels wherein the Seed is convey'd from the Testicles to the *Vesiculæ Seminales*.

**VASA Lactea**, the Milky Vessels in the Mesentery: They which reach from the Guts to the Glandules in the Mesentery, are said to be of the first sort; and they which reach from those Glandules to the Bag that carries the Chyle, are of the second sort.

Their Use is to convey the Chyle from the Guts to the little Bag which holds the Chyle, and thence to the *Ductus*, which conveys it to the *Thorax*. *Asellius* was the first who discovered them, and the dexterous *F. Ruyschius* afterwards discovered Valves in them. *Blanchard*.

**VASA Lymphaticæ**: See *Vena Lymphatica*.

**VASCULAR**, in *Anatomy*, is applied to any Thing which consists of divers Vessels, Veins, Arteries, &c.

**VASCULIFEROUS** *Plants*, are, according to the Botanists, such as have besides the common Calyx or Flower-Cup, a peculiar Vessel or Case to contain their Seed, one belonging to each Flower, but sometimes divided into distinct Cells. These have always a monopetalous Flower, either uniform or difform.

The former of these have their Seeds all divided,

1. Into two Partitions; as the *Hyoscyamus*, *Nicotiana*, *Priapeia*, and the *Gentiana*.

2. Into three Partitions; as the *Convolvulus*, *Speculum Veneris*, *Trachelium*, *Repunculus*, *Campanula*, *Repunculus Corniculatus*, &c.

3. Into four Partitions; as the *Stramonium*.

Those of the latter Kind, or which have a difform monopetalous Flower, as the *Linaria*, *Pinguicula*, *Antirrhinum*, *Aristolochia*, *Scrophularia*, *Digitalis*, *Pedicularis*, *Melampyrum* and *Euphrasia*, &c.

**VASES**, in *Architecture*, are certain Ornaments placed, representing the Vessels of the Ancients, used in Sacrifices, placed on Cornices, Socles or Pedestals.

**VASE**, in *Botany*, the Calyx or Cup; the Vase of a Tulip is the Top or Head of a Tulip, the Leaves of which form a Vase or Cup.

**VASE**, in *Architecture*, is used to signify the Body of the *Corinthian* and *Composite* Capital; sometimes called the *Campana* or *Bell*, and more commonly the *Tambour* or *Drum*.

**VASSAL**, signifies him that holds Land in Fee of his Lord (now he is called usually a *Tenant in Fee*) whereof some owe Fidelity and Service, and such are *Vassalli*. *Jurati*.

**VASTI Musculi**, are certain Muscles that contribute to the extending of the Leg, and are of two sorts, viz. *External* and *Internal*.

**VASTO**, is a Writ that lies for the Heir against the Tenant for Term of Life, or of Years, for making Waste, or for him in the Reversion or Remainder.

**VASTUM**, is a Waste or Common, lying open to the Cattle of all Tenants who have a Right of Commoning.

**VASTUS Externus**, is a Muscle of the Leg, so called, from its Magnitude and Situation. It arises outwardly tendinous, inwardly fleshy from the external Part of the great *Trochanter*, and *Linea Aspera* of the Thigh-bone, from whence its Fibres descend obliquely forwards; and, on the contrary, become outwardly fleshy, and tendinous internally; and so soon as they meet with the Tendon of the *Rectus Femoris*, grow perfectly tendinous. It helps to extend the *Tibia*.

**VASTUS Internus**, is a Muscle of the Leg, which hath its Denomination from its Situation and Magnitude. Its Beginning is large, partly tendinous, and partly fleshy; its being continued from the *Linea Aspera*, on the Back-part of the Thigh-bone, from immediately below the lesser *Trochanter*, 'till within three Fingers breadth above the inferior *Appendix* of the said Bone internally and laterally; from hence its fleshy Fibres descend obliquely outwards, in an almost Semi-circular Manner, and on a Sudden ceasing to be fleshy, its Tendon is united with that of the *Rectus*, together with the *Vastus Internus* and *Crureus*, and is inserted with them. It helps to extend the *Tibia*.



VAVASOR, *alias* VALVASOR, is one that in Dignities is next to a Baron: *vid. Braetton, l. 1. c. 8. and Camden, p. 188. and Spelman's Glossary.*

VAULT, in *Architecture*, is an arch'd Roof, so contrived that the several *Voussairs* or *Vault-stones* of which it consists, do by their Disposition sustain each other.

Master VAULT, is one that covers the principal Parts of a Building, in contradistinction to the *Lesser*, or subordinate, *Vaults*, which only cover some little Part, as a *Passage*, a *Gate*, &c.

Double VAULT, is one that is built over another, to make the exterior Decoration answer the interior, leaving a Space between the Convexity of the one, and the Concavity of the other.

A VAULT, in *Compartments*, is one whose inner Face is enrich'd with Pannels of Sculpture, separated by Platbands.

Key of a VAULT, is a Stone or Brick in the middle of a *Vault*, in the Form of a truncated Cone; serving to bind all the rest.

The Reins of a VAULT, or the filling up, are the Sides which sustain it. The *Pendentive* of a VAULT is the Part which is suspended between the Arches or Ogives.

The Impost of a VAULT, is the Stone on which the first *Voussair*, or Stone of the Vault is laid.

VECTIS, or the Lever, is the first of the Mechanick Powers, as they are usually called. This Dr. Wall's, in his *Mechanicks*, rightly considers as a *Right Line* perfectly inflexible, of no weight itself, or at least of an equable one throughout, accommodated to the raising or sustaining of heavy Bodies. This *Veetis* is always supported by a *Fulcrum*, on which it moves as on an immoveable Centre.

VECTIS; when the Weight lies beyond the *Fulcrum* or *Hypomocklion* with regard to the Power, then the *Veetis* is called *Heterodromus*; but when the Weight lies between the *Fulcrum* and the Power, so that 'tis not moved a contrary way with the Power, as in the former Case, but ascends or descends as the Power doth; then 'tis called *Veetis Homodromus*.

VECTOR, a Line supposed to be drawn from any Planet moving round a Centre, as the Focus of an Ellipsis, to that Centre or Focus, is by some Writers of the New Astronomy, called the *Vector*; because 'tis that Line by which the Planet seems to be carried round its Centre, and with which it describes proportional Area's in proportional Times.

VEDETTE, a *Military Term*, signifying a Centinel on Horse-back detach'd from the Main Body of the Army, to discover and give notice of the Enemies Designs.

VEER: The Seamen call *Veering* out a Rope, letting it go by Hand, or letting it run out of itself. Thus they say, *Veer more Cable*; that is, let more Cable run out. But they don't use this Word for the letting out of any running Rope, except the *Sheat*, but of that they say, *Veer more Sheat*; that is, let more of it run out.

The Word *Veer* is also used in reference to the Wind; for when it changeth often and suddenly, they say, the Wind *veereth*; also when a Ship, being under Sail, hath her *Sheat veered out*, they say, she goes *Veering*; that is, at large; neither by a Wind, nor directly before it, but between both, which they call also *Quartering*.

VEGETABLES, are such Natural Bodies as grow and increase from Parts organically formed, but have no proper Life nor Sensation.

VEGETATION, is the Way of Growth or Increase of Bulk, Parts and Dimensions, proper to all Trees, Shrubs Plants, and Herbs.

It hath been a general Opinion amongst almost all the Modern Naturalists, that the Vegetation of Plants, and even Minerals too, was chiefly owing to Water; and that not only as a Vehicle, to convey to them the fine rich Earth, &c. proper for their Nourishment; but that the Water was transmuted into the very Body of the Plant, and afforded the greatest Part of it, if not all the Matter with which they are nourished, and by which they grow and increase in Bigness. This Opinion, countenanced by very great Names, that Learned and Ingenious Naturalist, Dr. John Woodward, Author of the *Natural History of the Earth*, thought very well worth taking into serious Examination.

And in the first Place, he carefully examined all sorts of Water, and found, that the clearest, finest Spring-Water, which he could any where meet with, exhibited even to the naked Eye great Numbers of exceeding small terrestrial Particles, and that all other crasser Waters had these in yet much greater Quantity, and also that they were of a much larger Bulk.

He found this Terrestrial Matter contained in all Water, to be of two kinds: The one properly a *Vegetable Matter*, but consisting of very different Particles; some of which are proper for the Nourishment of some kinds of Plants; others for different sorts, &c. The other kind of Earthy Matter he found to be purely of a Mineral Nature; and this also was of very various and different kinds.

The former sort of Vegetable Earthy Matter abounds plentifully in all Waters; but for the *Mineral*, 'tis found mostly in Spring-water, next to that, in River-water, and least of all in Rain-water; tho' even there it is also to be found plentifully.

This Fact (he saith) any one may discover, by only keeping Water for a competent Time without stirring it, in a clear Glass Viol, close stop'd, to keep out Dust, &c. For then he will observe, that these very small Terrestrial Particles, which before were scarcely visible singly, will now combine together into larger and more conspicuous Masses, which by Degrees, will join together, and form Clouds as it were in the Water, which will grow daily more and more opacous and thick, by the continual Accession of new Matter. And if the Earthy Matter in the Water be chiefly of the *Vegetable* kind, it will turn the Water green, the usual Colour of Vegetables; and this will grow deeper and deeper coloured, but will not precipitate to the Bottom of the Glass, as the *Mineral* Matter will, if there be any considerable Quantity, by reason of its much greater specific Gravity. On the whole therefore he concludes, very justly, that there is in all Water a considerable Quantity of Earthy Matter: And in order to determine whether the Vegetation of Plants was chiefly owing to bare Water, or not rather to the *Terrestrial Matter* therein contained, he made, with very great Accuracy and Care, the following Experiments, as you will find in a Discourse of his, read before the Royal Society, and published in their *Transactions*, N<sup>o</sup>. 253.



Which *Experiments*, because they are done with an uncommon Care and Exactness, are a sufficient number of them, and are followed by very ingenious *Reflections*, serving to explicate many Difficulties in Philosophy, and to set the whole Affair of Vegetation in a very good Light; I shall give the Reader as followeth.

Anno Dom. 1691, I chose (saith he) several *Glass Viols*, that were all, as near as possible, of the same shape and bigness. After I had put what Water I thought fit into every one of them, and taken an Account of the *Weight* of it, I strained and tied over the Orifice of each Viol, a piece of Parchment, having an Hole in the Middle of it, large enough to admit the *Stem* of the *Plant* I designed to set in the Viol, without confining or straitening it, so as to impede its *Growth*. My Intention in this, was to prevent the enclosed Water from evaporating or ascending any other way than only through the Plant to be set therein.

Then I made choice of several Sprigs of *Mint*, and other *Plants* that were, as near as I could possibly judge, alike fresh, sound and lively. Having taken the *Weight* of each, I placed it in a Viol, ordered as above; and as the Plant imbibed and drew

off the Water, I took care to add more of the same from Time to Time, keeping an Account of the *Weight* of all I added. Each of the Glasses were, for better Distinction, and the more easy keeping a Register of all the Circumstances, noted with a different Mark or Letter, A, B, C, &c. and all set in a row in the same Window, in such manner, that all might partake alike of *Air*, *Light*, and *Sun*. Thus they continued from *July* the 20th to *October* the 5th, which was just 77 Days. Then I took them out, weighed the Water in each Viol, and the Plant likewise, adding to its *Weight* that of all the Leaves that had fallen off during the Time it stood thus. And, lastly, I computed how much each Plant had gained, and how much Water was spent upon it. The Particulars are as follows.

A. *Common Spear-mint*, set in *Spring-water*.

The Plant weighed, when put in *July* 20, just 27 Grains; when taken out *October* 5. 42 Grains. So that in this Space of 77 Days, it had gained in *Weight* 15 Grains.

The whole Quantity of Water expended during the 77 Days, amounts to 2558 Grains. Consequently, the *Weight* of the Water taken up, was  $170\frac{8}{13}$  Times as much as the Plant had got in *Weight*.

A. *Common Spear-mint* : *Spring-Water*.

| Weight of the Plant when first put in Water. | Weight of the Plant when taken out of the Water. | Weight gained by the Plant during the 77 Days. | Weight of the Water expended upon the Plant. | Proportion of the Increase of the Plant to the Expence of the Water. |
|--|--|--|--|--|
| 27 Grains.                                   | 42 Grains.                                       | 15 Grains.                                     | 2558 Grains.                                 | As 1 to $170\frac{8}{13}$ .  |

B. *Common Spear-mint* : *Rain-water*.

|                      |                      |                      |          |                              |
|----------------------|----------------------|----------------------|----------|------------------------------|
| 28 $\frac{1}{4}$ Gr. | 45 $\frac{3}{5}$ Gr. | 17 $\frac{1}{2}$ Gr. | 3004 Gr. | As 1 to $171\frac{23}{35}$ . |
|----------------------|----------------------|----------------------|----------|------------------------------|

C. *Common Spear-mint* : *Thames-water*.

|        |        |        |          |                             |
|--------|--------|--------|----------|-----------------------------|
| 28 Gr. | 54 Gr. | 26 Gr. | 2493 Gr. | As 1 to $95\frac{23}{26}$ . |
|--------|--------|--------|----------|-----------------------------|

D. *Common Solanum*, or *Night-shade* : *Spring-water*.

|        |         |        |          |                            |
|--------|---------|--------|----------|----------------------------|
| 49 Gr. | 106 Gr. | 57 Gr. | 3708 Gr. | As 1 to $65\frac{3}{17}$ . |
|--------|---------|--------|----------|----------------------------|

E. *Lathyres* seu *Cataputia Gerb.* *Spring-water*.

|        |                       |                     |          |                            |
|--------|-----------------------|---------------------|----------|----------------------------|
| 98 Gr. | 101 $\frac{1}{2}$ Gr. | 3 $\frac{1}{2}$ Gr. | 2501 Gr. | As 1 to $714\frac{4}{7}$ . |
|--------|-----------------------|---------------------|----------|----------------------------|

The Specimen *D* had several *Buds* upon it when first set in Water; these in some Days became fair *Flowers*, which were at length succeeded by *Berries*. Several other Plants were try'd, that did not thrive in Water, or succeed any better than the *Cataputia* foregoing.

The Viols *F* and *G* were filled, the former with *Rain*, and the other with *Spring-Water*, at the same time as those above-mention'd were, and stood as long as they did; but they had neither of them any Plant; my Design in these being only to inform my self, whether any Water exhaled out of the Glasses, otherwise than through the Bodies of the Plants. The Orifices of these two Glasses were covered with *Parchment*; each piece of it being perforated with an Hole of the same Bigness with those of the Viols above: In this I suspended a bit of Stick about the Thickness of the Stem of one of the aforesaid Plants, but not reaching down to the Surface of the included Water; I put them in thus, that the Water in these might not have more Scope to evaporate than that in the other Viols.

Thus they stood the whole 77 Days in the same Window with the rest; when, upon Examination, I found none of the Water in these wasted or gone off: Though I observed, both in these and the rest, especially after hot Weather, small Drops of Water, not unlike Dew, adhering to the Insides of the Glasses; that Part of them I mean, that was above the Surface of the inclosed Waters.

The Water in these two Glasses that had no Plants in them, at the End of the Experiment, exhibited a larger Quantity of Terrestrial Matter than that in any of those that had the Plants in them did. The Sediment in the Bottom of the Viols was greater, and the *Nubeculae* diffused thro' the Body of the Water thicker. And of that which was in the others, some of it proceeded from certain small Leaves that had fallen from that part of the Stems of the Plants that was within the Water, wherein they rotted and dissolved. The Terrestrial Matter in the *Rain-Water*, was finer than that in the *Spring-Water*.



Experiments, Anno 1692.

The Glasses made use of in this were of the same sort with those of the former Experiment ; and cover'd over with Parchment in like manner.

The Plants here were all *Spear-Mint* ; the most kindly, fresh, sprightly Shoots I could chuse. The Water and the Plants were weigh'd as above, and the Viols set in a Line, in a *South Window*, where they stood from *June* the 2d, to *July* the 28th, which was just 56 Days.

| A. Hyde-Park Conduit-Water, alone.   |  |  |   |  |
|--|--|--|---|--|
| The Weight of the Plant when first set in Water.   | Weight of the Plant when taken out of the Water. | What gain'd by the Plant during the 56 Days. | What of the Water is expend- ed upon the Plant. | Proportion of the In- crease of the Plant to the Expende of the Water. |
| 127 Grains.  | 255 Grains.                                      | 128 Grains.                                  | 14190 Grains.                                   | As 1 to 110 $\frac{1}{12}$ .   |
| I. The same Water, alone.  |  |  |   |  |
| 110 Gr.  | 249 Gr.  | 139 Gr.                                      | 13140 Gr.                                       | As 1 to 94 $\frac{74}{133}$ .  |
| K. The same Water, with an Ounce and a half of common Garden Earth dissolved in it.        |  |  |   |  |
| 76 Gr.   | 244 Gr.  | 168 Gr.                                      | 10731 Gr.                                       | As 1 to 63 $\frac{147}{168}$ .   |
| L. Hyde-Park Water, with the same Quantity of Garden-Mould as the former.                  |  |  |   |  |
| 92 Gr.   | 376 Gr.  | 284 Gr.                                      | 14950 Gr.                                       | As 1 to 52 $\frac{82}{284}$ .  |
| M. Hyde-Park Water, distilled with a gentle Still.   |  |  |   |  |
| 114 Gr.  | 155 Gr.  | 41 Gr.                                       | 8803 Gr.  | As 1 to 214 $\frac{29}{41}$ .  |
| N. The Residue of the Water which remain'd in the Still after that in M was distill'd off. |  |  |   |  |
| 81 Gr.   | 176 Gr.  | 94 Gr.                                       | 4344 Gr.  | As 1 to 46 $\frac{90}{94}$ .   |

H, was all along a very kindly Plant, and had run up above two Foot in Height. It had shot but one considerable collateral Branch ; but had sent forth many and long Roots, from which sprung very numerous, tho' small and short, lesser *Fibres*. These lesser Roots came out of the larger on two opposite Sides, for the most part ; so that each Root, with its *Fibrilla*, appeareth not unlike a small Feather. To these *Fibrillæ* adhered pretty much *Terrestrial Matter*. In the Water, which was at the last thick and turbid, was a green Substance, resembling a fine thin *Conserua*.

The Plant I, was as kindly as the former, but had shot no collateral Branches : Its *Roots*, the *Waters*, and the green Substance, all much as in the former.

The Plant K, tho' it had the Misfortune to be annoy'd with very small Insects, that happen'd to fix upon it, yet had shot very considerable collate- ral Branches ; and at least as many Roots as ei- ther in H or I, which had a much greater Quan- tity of *Terrestrial Matter* adhering to the Extremi- ties of them : The same green Substance here that was in the two preceding.

The Plant L, was far more flourishing than any of the precedent ; had several considerable collate- ral Branches, and very numerous Roots, to which *Terrestrial Matter* adhered very copiously.

The Earth in both these Glasses was very sensi- bly and considerably wast'd, and less than when first put in. The same sort of green Substance here, as in those above.

The Plant M, was pretty kindly ; had two small collateral Branches, and several Roots, tho not so many as that in H or I ; but as much *Ter- restrial Matter* adhering to them, as those had. The Water was pretty thick ; having very nume- rous small *Terrestrial Particles* swimming in it, and some Sediment at the Bottom of the Glas. The Glas had none of the green Matter above- mentioned in it.

The Plant N, was very lively, and had sent out six collateral Branches, and several Roots.

The Glas O, had also *Hyde-Park Conduit-Wa- ter*, in which was dissolv'd a Dram of *Nitre*. The *Mint* set in this, suddenly began to wither and de- cay, and died in a few Days, as likewise did two more Sprigs that were set in it successively. In another Glas I dissolv'd an Ounce of good Gar- den-Mould, and a Dram of *Nitre* ; and in a third, half an Ounce of Wood-ashes and a Dram of *Ni- tre* ; but the Plants in these succeeded no better than in the former. In other Glasses I dissolv'd several other sorts of Earth, Clay, Marls, and va- riety of Manures, &c. I set *Mint* in distilled *Mint-Water* ; and other Experiments I made of several



several Kinds, in order to get Light and Information what hastned or retarded, promoted or impeded *Vegetation*.

The *Glass P, Hyde-Park Conduit-Water*: In this I fixed a *Glass-Tube* of ten Inches long, the Bore about one sixth of an Inch in Diameter, filled with very fine and white Sand, which I kept from falling down out of the Tube into the Viol, by tying a thin Piece of Silk over that End of the Tube that was downwards. Upon Immersion of the lower End of it into the Water, this by little and little ascended quite to the upper Orifice of the Tube; and yet in all the 56 Days which it stood thus, a very inconsiderable Quantity of Water had gone off, viz. scarcely 20 Grains, tho' the Sand continued moist up to the Top 'till the very last. The Water had imparted a green Tincture to the Sand, quite to the very Top of the Tube: And in the Viol it had precipitated a greenish Sediment, mix'd with Black. To the Bottom and Sides of the Tube, as far as 'twas immerfed in the Water, adhered pretty much of the green Substance described above. Other-like Tubes I filled with *Cotton, Lint, Pith of Elder*, and several other porous *Vegetable Substances*; setting some of them in clear Water, others in Water tinged with *Saffron, Cochinele, &c.* And several others Trials were made, in order to give a Mechanical Representation of the Motion and Distribution of the Juices in Plants, and of some other *Phænomena* observable in *Vegetation*.

Several *Plants* being also set in the Viols Q, R, S, &c. ordered in like manner as those above, in *October*, and the following colder Months; these throve not near so much, nor did the Water ascend in nigh the Quantity it did in the hotter Seasons, in which the before-cited Trials were made.

Some Reflections upon the foregoing Experiments.

1. *In the Plants of the same kind, the less they are in Bulk, the smaller Quantity of the Fluid Mass in which they are set is drawn off; the Dispendium of it where the Mass is of equal Thickness, being pretty nearly proportion'd to the Bulk of the Plant.*

Thus, that in the Glass mark'd A, which weighed only 27 Gr. drew off but 2558 Gr. of the Fluid: And that in B, which weigh'd only  $28\frac{1}{4}$  took up but 3004 Gr. Whereas that in H, which weigh'd 127 Gr. spent 14190 Gr. of the *Liquid Mass*.

The Water seems to ascend up the Vessels of Plants in much the same manner as up a *Filter*; and 'tis no great Wonder, that the larger Filter should draw off more Water, than the lesser; or that a Plant that has more and larger Vessels, should take up a greater share of the Fluid in which it is set, than one that has fewer and smaller ones can. Nor do I note this as a Thing very considerable in it self, but chiefly in regard to what I am about next to offer: And that it may be seen, that in my other Collations of Things, I made due Allowance for this Difference.

2. *The much greater Part of the Fluid Mass that is thus drawn off, and conveyed into the Plant, does not settle or abide there; but passes thorough the Pores of them, and exhales up into the Atmosphere.*

That the Water in these Experiments ascended only through the Vessels of these Plants, is certain.

The *Glasses F and G*, that had no Plants in them, tho' disposed in like manner as the rest, remain'd at the End of the Experiment, as at first, and none of the Water was gone off: And that the greatest Part of it flies off from the Plant into the Atmosphere, is as certain.

The least Proportion of the Water expended, was to the Augment of the Plant, as 46 or 50 to 1. And in some, the Weight of the Water drawn off was 100, 200, nay, in one above 700 times as much as the Plant had received of Addition.

This so continual an Emission and Detachment of Water, in so great Plenty, from the Parts of the Plants, affords us a manifest Reason, why Countries that abound with Trees, and the larger Vegetables especially, should be very obnoxious to *Damps*, great Humidity in the Air, and more frequent Rains, than others that are more open and free. The great Moisture in the Air, was a mighty Inconvenience and Annoyance to those who first settled in *America*, which at that Time was much overgrown with Woods and Groves. But as these were burnt and destroy'd, to make way for Habitations and Culture of the Earth, the Air mended and cleared up apace, changing into a Temper much more serene and dry than before. Nor does this Humidity go off pure and alone, but usually bears forth with it many Parts of the same Nature with those whereof the Plant, through which it passes, consists. The *Craffer* indeed are not so easily born up into the Atmosphere; but are usually deposited on the Surface of *Leaves, Flowers*, and other Parts of the Plant. Hence come our *Manna's*, our *Honies*, and other *Gummous Exsudations of Vegetables*.

But the finer and lighter Parts are with greater Ease sent up into the Atmosphere.

Thence they are convey'd to our Organs of Smell, by the Air we draw in *Respiration*, and are pleasant or offensive, beneficent or injurious to us, according to the Nature of the Plants from whence they arise.

And since these owe their Rise to the Water that ascends out of the Earth through the Bodies of Plants, we cannot be far to seek for the Cause why they are more numerous in the Air; and we find a greater Quantity of Odours exhaling from Vegetables, in warm humid Seasons, than in any others whatsoever.

3. *A great part of the Terrestrial Matter that is mixed with Water, ascends up into the Plant, as well as the Water.*

There was much more Terrestrial Matter at the End of the Experiment in the Water of the *Glasses F and G*, that had no Plants in them, than in those that had Plants.

The *Garden Mould* dissolved in the *Glasses K and L*, was considerably diminished, and carried off; nay, the *Terrestrial and Vegetable Matter* was



was born up in the *Tubes* filled with *Sand*, *Cotton*, &c. in that Quantity, as to be evident even to Sense. And the Bodies in the Cavities of the other Tubes, that had their lower Ends immers'd in Water, wherein *Saffron*, *Cochinele*, &c. had been infused, were tinged with *Yellow Purple*, &c.

If I may be permitted to look abroad a while towards our *Shores* and *Parts* within the *Verge* of the *Sea*, these will present us with a large Scene of *Plants*, that along with the Vegetable, take up into them meer *Mineral Matter* also in great abundance: Such are our *Sea Purslain*, the several sorts of *Alga's*, of *Samphires*, and other *Marine Plants*. Those contain *common Sea Salts*, which is all one with the *Fossil*, in such Plenty, as not only to be plainly distinguished on the *Palate*, but may be drawn forth of them in considerable Quantity; nay, there want not those, who affirm, There are *Plants* found that will yield *Nitre*, and other *Mineral Salts*; of which, indeed, I am not so far satisfied, that I can depend on the Thing, and therefore give this only as an *Hint* for Enquiry.

To go on with the *Vegetable Matter*, how apt, and how much dispos'd this, being so very *fine* and *light*, is to attend Water in all its *Motions*, and follow it into each of its *Recesses*, is manifest, not only from the Instances above alledged, but many others. *Percolate* it with all the Care imaginable, *Filter* it with never so many *Filtrations*, yet some *Terrestrial Matter* will remain. 'Tis true, the Fluid will be thinner every time than other, and more disengaged of the said Matter, but never wholly free and clear. I have filtr'd Water thro' several Sheets of thick Paper, and after that thro' very close fine Cloth twelve times doubled; nay, have done this over and over, and yet a considerable Quantity of this Matter discovered it self in the Water after all. Now, if it thus passes *Interstices* that are so very small and fine along with the Water, 'tis the less strange it should attend it in its Passage through the Ducts and Vessels of Plants. 'Tis true, filtering and distilling of Water, intercepts and makes it quit some of the Earthy Matter it was before impregnated withal; but then, that which continues with the Water after this, is fine and light, and such consequently as is in a peculiar Manner fit for the Growth and Nourishment of Vegetables. And this is the Case of Rain-water. The Quantity of *Terrestrial Matter* it bears up into the *Atmosphere* is not great: But that which it does bare up, is mainly of that light kind or Vegetable Matter, and that too perfectly dissolved, and reduced to single Corpuscles, all fit to enter the *Tubules* and Vessels of *Plants*. On which account 'tis, that this Water is so very *Fertile* and *Prolific*.

The Reason why in this *Proposition* I say only a great Part of the *Terrestrial Matter* that is mix'd with the Water, ascends up with it into the Plant is, because all of it cannot. The *Mineral Matter* is a great deal of it, not only gross and ponderous, but scabrous and inflexible; and so not disposed to enter the Pores of the Roots. And a great many of the simple Vegetable Particles by Degrees unite, and form some of them small *Clods* or *Molecules*; such as those mentioned in H, K and L, sticking to the Extremities of the Roots of those Plants. Others of them intangled in a looser Manner, and form the *Nubeculae*, and green Bodies so commonly

observed in stagnant Water. These, when thus conjoined, are too big to enter the *Pores*, or ascend up the Vessels of Plants, which singly they might have done.

They who are conversant in *Agriculture*, will easily subscribe to this. They are well aware, that be their *Earth* never so rich, so good, and so fit for the Production of *Corn* or other *Vegetables*, little will come of it, unless the Parts of it be separated and loose. 'Tis on this account they bestow the Pains they do in the *Culture* of it; in *Digging*, *Plowing*, *Harrowing*, and breaking of the clodded Lumps of Earth. 'Tis the same way that *Sea Salt*, *Nitre*, and other *Salts* promote *Vegetation*.

I am sorry I cannot subscribe to the Opinion of those learned *Gentlemen*, who imagine *Nitre* too essential to Plants; and that nothing in the *Vegetable Kingdom* is transacted without it. By all the Trials I have been able to make, the thing is quite otherwise; and when contiguous to the Plant, it rather destroys, than nourishes it. But this *Nitre* and other *Salts* certainly do; they loosen the Earth and separate the concreted Parts of it, by that means fitting and disposing them to be assumed by the Water, and carried up into *Seed* or *Plant*, for its *Formation* and *Augment*.

There is no Man but must observe, how apt all sorts of *Salts* are to be wrought upon by *Moisture*; how easily they liqueate and run with it; and when these are drawn off, and have deserted the Lumps wherewith they were incorporated, those must moulder immediately, and fall asunder of course. The hardest Stone we meet with, if it happen, as frequently it does, to have any sort of *Salt* intermixed with the Sand, of which it consists, upon being expos'd to an *humid Air*, in a short Time dissolves and crumbles all to Pieces, and much more will clodded Earth or Clay, which is not of near so compact and so solid a Constitution as Stone is. The same way likewise is Lime serviceable in this Affair. The Husbandman says of it, that it does not *fatten*, but only *mellows* Ground. By which they mean, that it does not contain any thing in itself that is of the same Nature with the *Vegetable Mould*, or afford any Matter fit for the Formation of *Plants*, but merely softens and relaxes the Earth, by that means rendring it more capable of entering the *Seeds* and *Vegetables* set in it, in order to their Nourishment, than otherwise it would have been. The Properties of Lime are well known, and how apt 'tis to be put into *Ferment* and *Commotion* by *Water*: Nor can such *Commotion* ever happen when *Lime* is mixed with *Earth*, however hard or clodded that may be, without opening and loosening of it.

4. *The Plant is more or less nourished and augmented in Proportion as the Water in which it stands contains a greater or smaller Quantity of proper Terrestrial Matter in it.*

The Truth of this *Proposition* is so evidently discernable through the whole Process of these Trials, that I think no doubt can be made of it.

The Mint in the Glass C, was of much the same Bulk and Weight with those in A and B: But the Water in which that was, being *River Water*, which was apparently stored more copiously with *Terrestrial Matter* than the Spring or Rain Water wherein they stood, were; it had thriven at



almost double the Bulk that either of them had, and with a less Expence of Water too. So likewise the *Mint* in L, in whose Water was dissolved a small Quantity of good Garden Mould, tho' it had the Disadvantage to be less when first set, than either of the *Mints* in H or I, whose Water was the very same with that in L, but had none of that Earth mixed with it, yet in a short time the Plant not only overtook, but much outstrip'd those; and at the End of the Experiment, was very considerably bigger and heavier than either of them.

In like manner, the *Mint* in N, tho' less in the Beginning than that in M, being set in that *thick, turbid, feculent Water* that remain'd behind, after that wherein M was placed was stilled off, had in fine more than double its original Weight and Bulk; and received above twice the additional Encrease than that in M, which stood in thinner *distilled Water*, had done: And which is not less considerable, had not drawn off half the Quantity of Water that that had.

Why, in the Beginning of this Article, I limit the Proportion of the Augment of the *Plant* to the Quantity of the proper Terrestrial Matter in the Water, is, Because all, even the *Vegetable Matter*, to say nothing of the *Mineral*, is not proper for the Nourishment of every *Plant*.

There may be, and doubtless are, some Parts in different Species of *Plants*, that may be much alike. and so owe their Supply to the same common Matter: But 'tis plain, all cannot. And there are other *Parts* so differing, that 'tis no ways credible they should be formed all out of the same sort of *Corpuscles*: So far from it, that there want not good Indications, as we shall see by and by, That every kind of *Vegetable* requires a peculiar and specifick Matter for its *Formation* and Nourishment; yea, each part of the same *Vegetable* does so; and there are very many and different Ingredients go to the Composition of the same individual Plant.

If therefore the Soil wherein any *Vegetable* or Seed is planted, contains all or most of these Ingredients, and those in due Quantity, 'twill grow and thrive there; otherwise 'twill not. If there be not as many sorts of *Corpuscles* as are requisite for the Constitution of the main and more essential Parts of the Plant, 'twill not prosper at all. If there be these, and not in sufficient Plenty, 'twill starve, and never arrive to its natural Stature: Or if there be any the less *necessary* and *essential* *Corpuscles* wanting, there will be some Failure in the *Plant*; 'twill be defective in *Taste*, in *Smell*, in *Colour*, or some other way.

But tho' the Tract of Land may happen not to contain proper Nourishment for the Constitution of some one peculiar kind of *Plant*; yet it may for several *others*, and those much differing amongst themselves.

The *Vegetable Particles* are commixt and blended in the Earth, with all the Diversity and Variety, as well as all the Uncertainty conceivable. (I have given some Intimations of this in *Nat. Hist. of the Earth*, Page 228, &c. and shall not repeat them here.)

It is not impossible to imagine, how *one, uniform, homogeneous Matter*, having its Principles or original *Parts* all of the same *Substance, Constitution, Magnitude, Figure*, and *Gravity*, should ever constitute *Bodies* so egregiously unlike, in all those respects, as *Vegetables* of different kinds are; nay, even as

the different Parts of the same *Vegetable*: That one should carry a *Rosinous*, another a *Milky*, a third a *Yellow*, a fourth a *Red Juice* in its Veins; one afford a *fragrant*, another an *offensive Smell*; one be *sweet* to the Taste, another *bitter, acid, acerb, austere*, &c. That one should be *nourishing*, another *poisonous*, one *purging*, another *astringent*: That there should be that vast Difference in them, in their several *Constitutions, Makes, Properties and Effects*, and yet all arise from the very same sort of *Matter*, would be very strange. And, to note that by the Bye, this Argument makes equally strong against those who suppose mere *Water* the *Matter* out of which all *Bodies* are formed.

The *Cataputia*, in the Glass E, received but very little Encrease, only three Grains and a half, all the while it stood, tho' 2501 Gr. of *Water* were spent upon it. I will not say the Reason was, Because the *Water* did not contain in it *Matter* fit and proper for the Nourishment of that peculiar and remarkable *Plant*. No, it may be, the *Water* was not a proper *Medium* for it to grow in: And we know, there are very many *Plants* that will not thrive in it.

Too much of that *Liquor*, in some *Plants*, may probably hurry the Terrestrial Matter thro' their Vessels too fast for them to arrest and lay hold of it. Be that as it will, 'tis most certain, there are peculiar Soils that suit particular *Plants*.

In *England*, *Cherries* are observed to succeed best in *Kent*; *Apples* in *Herefordshire*; *Saffron* in *Cambridgeshire*; *Woad* in two or three of our *Midland Counties*; and *Teazles* in *Somersetshire*. This is an Observation that hath held in all *Parts*, and indeed in all Ages of the World. The most ancient Writers of Husbandry took Notice of it; and are not wanting in their Rules, for making choice of Soils suited to the Nature of each kind of *Vegetable* they thought valuable or worth propagating.

But, which is a further Proof of what I am here endeavouring to advance, That Soil that is once proper and fit for Production of some one sort of *Vegetable*, does not ever continue to be so. No, in Tract of Time, it loses that Property; but sooner in some Lands, and later in others. This is what all, who are conversant in these Things, know very well.

If *Wheat*, for Example, be sown upon a Tract of Land that is proper for that Grain, the first Crop will succeed very well, and perhaps the second, and the third, as long as the Ground is in Heart, as the *Farmers* speak: But in a few Years 'twill produce no more, if sowed with that Corn. Some other Grain indeed it may, as Barley: And after this has been sown so often, that the Land can bring forth no more of the same, it may afterwards yield some good *Oats*, and perhaps *Pease* after them: At length it will become barren; the *Vegetative Matter* that at first it abounded withal, being reduced forth of it by those successive Crops, and most of it born off. Each sort of *Grain* takes forth that peculiar *Matter* that is proper for its own Nourishment. First, the *Wheat* draws off those Particles that suit the Body of that Plant, the rest lying all quiet and undisturb'd the while. And when the Earth has yielded up all them, those that are proper for *Barley*, a different Grain remain still behind, 'till the successive Crops of that *Corn* fetch them forth too: And so the *Oats* and *Pease* in their Turn, 'till in fine all is carried off, and the Earth



Earth in a great Measure drained of that sort of Matter.

After all which, that very Tract of Land may be brought to produce another Series of the same *Vegetables*, but never 'till it is supplied with a new Fund of *Matter* with the like sort of that it at first contained. This Supply is made several ways: By the Ground's lying fallow for some time, till the Rain has poured down a fresh Stock upon it: Or by the Tiller's Care, in Manuring of it. And for further Evidence that this Supply is in reality of like sort, we need only reflect a while upon those *Manures* that are found by constant Experience best to promote *Vegetation*, and the Fruitfulness of the Earth. These are chiefly either *Parts of Vegetables*, or of *Animals*, which indeed either derive their own Nourishment immediately from *Vegetable Bodies*, or from other *Animals* that do so. In particular, the *Blood*, *Urine*, and *Excrements of Animals*; *Shaving of Horns*, and of *Hoofs*; *Hair*, *Wooll*, *Feathers*, *calcined Shells*, *Lees of Wine*, and of *Beer*, *Ashes* of all sorts of *Vegetable Bodies*, *Leaves*, *Straw*, *Roots*, and *Stubble* turned into Earth by plowing or otherwise, to rot and dissolve there. These, I say, are our best *Manures*; and being *Vegetable Substances*, when refunded back again into the Earth, serve for the Formation of other like Bodies.

Not wholly to confine our Thoughts to the Fields, let us look a while into our Gardens, where we shall meet with still further Confirmations of the same Thing. The *Trees*, *Shrubs*, and *Herbs*, cultivated in these, after they are continued in one Station, till they have derived thence the greater Part of the Matter fit for their *Augment*, will decay and degenerate, unless either fresh Earth, or some fit Manure, be applied unto them. 'Tis true, they may maintain themselves there for some Time, by sending forth Roots further and further, to a great Extent all round, to fetch in more remote Provision: But at last all will fail; and they must either have a fresh Supply brought to them, or they themselves be removed and transplanted to some other Place better furnished with Matter for their Subsistence. And accordingly, Gardeners observe, That Plants that have stood a great while in a Place, have longer Roots than usual; Part of which they cut off when they transplant to a fresh Soil, as now not of any further Use to them.

All these Instances, to pass over a great many others that might be alledged, point forth a particular *Terrestrial Matter*, and not Water, for the Subject to which Plants owe their Increase: Were it Water only, there would be no need of *Manures*, or of Transplanting them from Place to Place. The Rain falls in all Places alike, in this Field and in that indifferently, on one side of an Orchard or Garden as well as another. Nor could there be any reason, why a Tract of Land should yield *Wheat* one Year, and not the next, since the Rain showers down alike in each. But I am sensible I have carried this Article to too great a Length, which yet on so ample and extensive a Subject, 'twas not easy to avoid.

5. *Vegetables are not formed of Water, but of a certain peculiar Terrestrial Matter.*

It hath been shewn, That there is a considerable Quantity of this Matter contained both in *Rain*, *Spring*, and *River-water*; that the much greatest

Part of the Fluid Mass that ascends up into Plants, does not settle or abide there, but passes through the Pores of them, and exhales up into the Atmosphere; that a great Part of the *Terrestrial Matter*, mixed with the Water, passes up into the Plant along with it, and that the Plant is more or less augmented in Proportion, as the Water contains a greater or smaller Quantity of that Matter. From all which we may very reasonably infer, That *Earth*, and not *Water*, is the Matter that constitutes *Vegetables*.

The Plant in E drew up into it 2501 Grains of the *Fluid Mass*, and yet had received but  $3\frac{1}{2}$  Gr. of Encrease from all that.

The *Mint* in L, tho' it had at first the Disadvantage to be much less than that in I, yet being set in *Water*, wherewith Earth was plentifully mixed, and that in I, only in *Water*, without any such additional Earth, it had vastly outgrown the other, weighing at last 145 Gr. more than that did, and so having gain'd above twice as much as the other had.

In like manner, that in K, tho' 'twas a great deal less when put in than that in I, and was also impair'd and offended by Insects, yet being planted in *Water* wherein Earth was dissolved, whereas the *Water* in which I stood, had none, it not only overtook, but considerably surpassed the other, weighing at last 29 Gr. more than that in I, and yet had not expended so much *Water* as that by above 2400 Gr.

The Plant in N, tho' at first a great deal less than that in M, yet being set in the *foul crass Water* that was left in the Still, after that in which M was set, was drawn off, in conclusion had gain'd in Weight above double what that in the finer and thinner *Water* had.

The Proportion of the Augment of that Plant that thrived most, was to the Fluid Mass spent upon it, but as 1 to 46; in others, 'twas as 1 to 60, 100 to 200; nay, in the *Cataputia*, 'twas but as 1 to 714.

The *Mint* in B took up 39 Gr. of *Water* a day, one day with another; which was much more than the whole Weight of the Plant originally; and yet, withal this, it gained not  $\frac{1}{4}$  of a Grain a day in Weight.

Nay, that in H took up 253 Gr. a day of the Fluid, which was near twice as much as its original Weight, it weighing, when first set in the *Water*, but 127 Gr. And after all, the daily Encrease of the Plant was no more than  $2\frac{1}{3}$  Gr.

6. *Spring and Rain-water contain pretty near an equal Charge of Vegetable Matter; River-water more than either of them.*

The Plants in the Glasses, A, B, and C, were at first of much the same Size and Weight. At the End of the Experiment, the *Mint* in A had gain'd 15 Gr. out of 2558 Gr. of *Spring-water*: That in B,  $17\frac{1}{2}$  Gr. out of 3004 Gr. of *Rain-water*; but that in C had got 26 Gr. out of only 2493 Gr. of *River-water*.

I do not found this Proposition solely upon those Trials, having made some more, which I do not relate here, that agree well enough with these: So that the Proportions here delivered, will hold for the main; but a strict and just Comparison is hardly to be expected; so far from it, that I make no doubt, but the *Water* that falls in *Rain*, at some times,



times, contains a greater Share of *Terrestrial Matter*, than that which falls at others. A more powerful and intense Heat must needs hurry up a larger Quantity of that Matter along with the humid *Vapours*, that form *Rain*, than one more feeble and remiss ever possibly can. The Water of one Spring may flow forth with an higher Charge of this Matter, than that of another; this depending partly upon the quickness of the *Ebullition* of the Water; and partly, upon the Quantity of that *Matter* latent in the *Strata* through which the Fluid passes, and the greater or less Laxity of those *Strata*. For the same Reason, the Water of one River may abound with it more than that of another; nay, the same River, when much agitated and in *Commotion*, must bear up more of it, than when it moves with less *Rapidity* and *Violence*.

That there is a great Quantity of this Matter in Rivers; and that it contributes vastly to the ordinary Fertility of the Earth, we have an illustrious Instance in the *Nile*, the *Ganges*, and other *Rivers*, that yearly overflow the neighbouring *Plains*. Their *Banks* shew the fairest and largest *Crops* of any in the whole World; they are even loaded with the multitude of their Productions; and those who have not seen them, will hardly be induced to believe the mighty Returns those *Tracts* make, in comparison of others, that have not the Benefit of like *Inundations*.

7. *Water serves only for a Vehicle to the Terrestrial Matter which forms Vegetables, and does not itself make any Addition unto them.*

Where the proper *Terrestrial Matter* is wanting, the *Plant* is not augmented, tho' never so much Water ascend into it.

The *Cataputia* in E, took up more Water than the *Mint* in C, and yet had grown but very little, having received only  $3\frac{1}{2}$  Gr. of additional Weight, whereas the other had received no less than 26 Grains.

The *Mint* in I, was planted in the same sort of Water as that in K was; only the latter had Earth dissolved in Water, and yet that drew off 13140 Gr. of *Water*, gained itself no more than 139 Gr. in Weight; whereas the other took up but 10731 Gr. of *Water*, and was augmented 168 Gr. in Weight; consequently, that spent 2409 Gr. more of the Water than *this* in K did, and yet was not so much encreased in Weight as this, by 29 Grains.

The *Mint* in M stood in the very same kind of Water as that in N did. But the Water in M having much less *Terrestrial Matter* in it than that in N had, the Plant bore up 8800 Gr. of it, gaining itself only 41 Gr. the while; whereas that in N drew off no more than 4344 Gr. and yet was augmented 94 Gr. So that it spent 4459 Gr. of Water more than that did; and yet was not it self so much encreased in Weight as that was by 53 Grains.

This is both a very fair and a very conclusive Instance; on which account 'tis that I make often use of it. Indeed they are all so; and to add any thing further on this Head, will not be needful.

'Tis evident therefore, Water is not the Matter that composes Vegetable Bodies; 'tis only the Agent that conveys that Matter to them that introduces and distributes it to their several Parts for their Nourishment. That *Matter* is sluggish and

inactive, and would lie eternally confined to its Beds of Earth, without ever advancing up into *Plants*, did not Water, or some like Instrument, fetch it forth, and carry it unto them.

That therefore there is that plentiful Provision and vast Abundance of it supplied to all Parts of the Earth, is a Mark of a *Natural Providence* super-intending over the Globe we inhabit, and ordaining a due Dispensation of that Fluid, without the Ministry of which the noble Succession of Bodies we behold in *Animals*, *Vegetables*, and *Minerals*, should be all at a stand. But to keep to *Plants*, 'tis manifest, Water, as well upon this, as upon the other Hypothesis, is absolutely necessary in the Affair of *Vegetation*; and it will not succeed without it: Which indeed gave occasion to the Opinion, that *Water* itself nourished, and was changed into Vegetable Bodies. They saw, that tho' these were planted in a Soil never so Rich, so Happy, so Advantageous, nothing came of it, unless there was *Water* too in considerable Quantity.

And it must be allowed, *Vegetables* will not come on or prosper, where that is wanting. But yet what these Gentlemen inferred thence, was not, we see, well grounded.

This *Fluid* is capacitated for the Office here assigned it, several ways. By the Figure of its Parts, which, as appears from many Experiments, is exactly and mathematically Spherical; their Surfaces being perfectly Polite, and without any the least Inequalities. 'Tis evident, Corpuscles of such a Figure are easily susceptible of Motion, yea, far above any others whatsoever; and consequently the most capable of moving and conveying other Matter that is not so active and voluble. Then the Intervals of Bodies of that Figure are, with respect to their Bulk, of all others, the largest, and so the most fitting to receive and entertain foreign Matter in them. Besides, as far as the Trials hitherto made inform us, the constituent Corpuscles of Water are each, singly considered, absolutely solid, and do not yield to the greatest external Force. This secures their Figure against any Alteration; and the Intervals of the Corpuscles must be always alike.

By the latter, 'twill be ever disposed to receive Matter into it: And by the former, when once received, to bear it along with it.

*Water* is further capacitated to be a Vehicle to this Matter, by the Tenuity and Fineness of the Corpuscles of which it consists. We hardly know any Fluid in all Nature, except Fire, whose Constituent Parts are so exceeding subtil and small, as those of Water are. They'll pass Pores and Interstices, that neither Air nor any other Fluid will. This enables them to enter the finest Tubes and Vessels of Plants, and to introduce the *Terrestrial Matter*, conveying it to all Parts of them; whilst each, by means of Organs 'tis endowed with for the Purpose, intercepts and assumes into itself such Particles as are suitable to its own Nature, letting the rest pass on through the common Ducts: Nay, we have almost every where Mechanical Instances of much the same Tenor.

'Tis obvious to every one, how easily and suddenly Humidity, or the Corpuscles of Water sustained in the Air, pervade and insinuate themselves into Cords, however tightly twisted into Leather, Parchment, Vegetable Bodies, Wood, and the like.



This it is that fits them for Hygrometers, and to measure and determine the different Quantities of Moisture in the Air, in different Places and Seasons.

How freely Water passes and carries with it Terrestrial Matter through Filtres, Colatures, Distillations, &c. hath been intimated already.

8. *Water is not capable of performing this Office to Plants, unless assisted by a due Quantity of Heat; and this must concur, or Vegetation will not succeed.*

The Plants that were set in the Glasses Q, R, S, &c. in *October*, and in the following colder Months, had not near the Quantity of Water sent up into them, or so great an additional Encrease by much as those that were set in *June, July*, and the hotter Months. 'Tis plain, Water has no power of moving itself, or rising to the vast Height it does in the more tall and lofty Plants; so far from this, that it does not appear from any Discovery yet made, that even its own Fluidity consists in the intestine Motion of its Parts; whatever some otherwise very learned and knowing Persons may have thought. There is no need of any thing more for solving all the Phænomena of *Fluidity*, than such a Figure and Disposition of Parts, as Water has. Corpuscles of that Make, and that are all absolutely *Spherical*, must stand so very ticklish and nicely upon each other, as to be susceptible of every Impression, and tho' not perpetually in Motion, yet must be always ready and liable to be put into it, by any the slightest Force imaginable. It is true, the Parts of Fire or Heat are not capable of moving themselves any more than those of Water; but they are more subtil, light, and active than those are, and so more easily put into Motion.

In fine, 'tis confident, and Matter of Fact, that Heat does operate upon, and move the Water, in order to its carrying on the Work of *Vegetation*; but how 'tis agitated itself, and when the Motion first begins, this is no fit Place to enquire.

That the Concourse of Heat in this Work, is really necessary, appears not only from the Experiments before us, but from all Nature: From our Fields and Forests, our Gardens and our Orchards, we see in *Autumn*, as the Sun's Power grows gradually less and less, so its Effects on Plants are remitted, and their *Vegetation* slackens by little and little.

Its Failure is first discernible in Trees; these are raised highest above the Earth, and require a more intense Heat to elevate the Water charged with its Nourishment, to the Tops and Extremities of them; so that for want of fresh Support and Nutriment, they shed their Leaves, unless secured by a very firm and hardy Constitution indeed, as our *Evergreens* are; next the Shrubs part with theirs, and then the Herbs and lower Tribes; the Heat being at length not sufficient to supply even these, tho' so near the Earth, the Fund of their Nourishment. As the Heat returns the succeeding Spring, they all recruit again, and are furnished with fresh Supplies and Verdure: But first those which are lowest and nearest the Earth, Herbs, and they that require a lesser Degree of Heat to raise the Water with its Earthy Charge into them. Then the Shrubs and higher Vegetables in their Turns; and lastly, the Trees. As the Heat encreases, it grows too powerful, and hurries the Matter with too great Rapidity thro' finer, and more tender Plants. These therefore go off and decay; and others that are more hardy and vigorous, and require a greater

degree of Heat, succeed in their Order. By which Mechanism, provident Nature furnishes us with a very various and differing Entertainment; and what is best suited to each Season, all the Year round.

As the Heat of the several Seasons affords us a different Face of Things, so the several distant Climates shew different Scenes of Nature, and Productions of the Earth.

The hotter Countries yield ordinarily the largest and tallest Trees, and those too in a much greater Variety than the colder ever do. Even those Plants which are common to both, attain to a much greater bulk in the Southern, than in the Northern Climes; nay, there are some Regions so Bleak and Chill, that they raise no *Vegetables* at all to any considerable Size. This we learn from *Greenland*, from *Iceland*, and other Places of like cold Site and Condition. In these no Tree ever appears, and the very Shrubs they afford, are few, little, and low.

Again, In the warmer Climates, and such as do furnish forth Trees, and the larger *Vegetables*, if there happen a Remission, or Diminution of the usual Heat, their Productions will be impeded or diminished in Proportion.

Our late colder Summers have given us Proof enough of this. For tho' the Heat we have had was sufficient to raise the *Vegetative Matter* into the lower *Plants*, into our Corns, our Wheat, Barley, Pease, and the like; and we have had Plenty of Strawberries, Raspberries, Currants, Gooseberries, and the Fruits of such other *Vegetables* as are low and near the Earth: Yea, and a moderate store of Cherries, Mulberries, Plums, Filberds, and some others that grow at a somewhat greater Height; yet our Apples, or Pears, Walnuts, and the Productions of the taller Trees have been fewer, and those not so kindly, so thoroughly ripened, and brought to that Perfection they were in the former more benign and warm Seasons. The Dwarf-apple and Pear-trees have succeeded better; and indeed in Trees of the same kind, those that keep closest to the Earth, always produce the most and best Fruit. For which reason it is that the Gardeners check and restrain the Growth of their better Fruit-trees, and prevent their running up too great a Height: Now, even the lower Fruits and Greens have had some share in the common Calamity, and fallen short both in Number and Goodness of what the hotter and kinder Seasons were wont to shew us.

As to our Grapes, Abricots, Peaches, Nectarins, and Figs, being transplanted hither out of hotter Climes, 'tis the less wonder we have of late had so general a Failure of them.

Nor is it the Sun, or the ordinary Emission of the Subterranean Heat only, that promotes *Vegetation*; but any other indifferently, according to its Power and Degree.

This we are taught by our Stoves, Hot-beds, and the like. All Heat is of like kind; and wherever is the same Cause, there will be constantly the same Effect.

There's a *Procedure* in every part of Nature, that is perfectly Regular, and Geometrical, if we can but find it out; and the farther our Searches carry us, the more shall we have Occasion to admire this, and the better 'twill compensate our Industry.

VEHICLE, in the General, is that which carries or bears any thing along; as the *Serum*, or watery Humour, they say is the Vehicle which serves to convey the Blood-Particles, and to disperse them



all over the Body: And in Pharmacy, that Liquid in which any Powder, or such like Medicine, is taken, they call a proper Vehicle for it.

**VEGETATIVE**, a Term applyed to that Principle or Part in Plants, by Vertue of which they receive Nourishment, or grow and vegetate.

**VEJOURS**, are such as are sent by the Court to take View of any Place in Question, for the better Decision of the Right. It also signifies such as are sent to view those that Essoin themselves *de malo Lecti*, whether they be in truth so sick as they cannot appear, or whether they counterfeit. This Word is also used for those that are appointed to view an Offence, as a Man murdered, &c. See *View*.

**VEIN**, is a Vessel in an Animal Body, made to receive and bring the Blood back again from the Arteries.

The Veins consist of four Tunicks, a Nervous, a Glandulous, a Muscular, and a Membranaceous one. The Branches of the *Vena Cava*, above the Heart, are called *Jugular Veins*, which go towards the Head; they which go towards the Arms, are called *Axillary*; that about the Heart are *Coronary*; in the Lungs *Pulmonary*; in the Liver *Hepatic*, or *Liver Vein*; in the *Diaphragma*, *Phrenica*; in the Thighs *Crural*; in the Reins *Emulgents*; and so from its various Ramifications it is variously denominated. *Blanchard*.

**VELAMEN**, in *Chirurgery*, the Bag, Skin or Bladder of an Imposthume or Swelling, *L*.

**VELAMENTUM Bombycinum**, in *Anatomy*, the Velvet Membrane, or Skin of the Intestines, *L*.

**VELLICATION**, with *Physicians*, a sudden Convulsion happening to the Fibres of the Muscles.

**VELOCITY**, in *Mechanicks*; *Swiftnefs*, *Celerity*, or that Affection of Motion, whereby a Moveable is dispos'd to run over a certain Space in a certain Time, and is still proportional to the Space moved. Called also *simple* or *absolute Velocity*.

*Relative or respective VELOCITY*, in *Mechanicks*, is that with which two distant Bodies approach one another, and come to meet in a Time either longer or less; whether only one of them moves to the other that is at Rest, or whether they both move. As if two Bodies come nearer each other by three Foot in one Second of Time, their respective Velocity is double that of two others which only approach one Foot and a half in the same Time.

**VENA Cava**: See *Cava Vena*.

**VENA Portæ**, is a notable Vein, so called from the two Eminences, called by *Hippocrates* *πυλαι*, between which it enters the Liver. The

**VENA Portæ**, as it enters into the Liver, is invested with another Coat, which some call *Vagina Portæ*, its Sheath; others *Capsula* or *Involucrum*, its Case or Cover, and *Capsula communis*, because the *Porus bilarius* is involved in it as well as the *Porta*.

This outer Coat it has immediately from the Membrane that cloaths the Liver; that is, it is continued from it, though it be of a clear other Substance, namely more dense and carnous; it is invested with it in all its Ramifications, and so having a double Coat, is in that respect an Artery; as also in that it brings Blood to its Liver for its Nourishment, as well as for other Uses; and lastly, into the *Capsula*, it has an obscure Pulsation (according to *Dr. Glisson*.)

When it is enter'd about half an Inch into the Liver, it is carried partly to the Right Hand, partly to the Left, and so is shap'd into a *Sinus* as it were, and thence is divided into five large Branches, Four whereof are diffus'd all over the hollow Side of the Liver, but the Fifth ascends streight to its upper Side, where it disperses it self. The said *Sinus* is more conspicuous in an *Embryo*, because the great Influx of nutritious Juice by the Umbilical Veins enlarge it much. Some make it a sort of a Heart, observing in it an obscurer kind of *Systole* and *Diastole*, whereby the Motion of the Blood in the Branches of the *Porta* within the Liver, is promoted in like manner, as it is in the *Arteria pulmonaris*, and *Aorta* by the Right and Left Ventricles of the Heart. Without which Pulsation, they think the Blood would hardly pass out of the larger Branches of the *Porta* into the narrower, and so on into the Roots of the *Cava*.

In an *Embryo* very observable is the *Tubulus*, or *Canalis Venosus*, which passes directly out of this *Sinus* into the *Cava*, almost opposite to the Mouth of the Umbilical Vein that opens into the *Sinus*.

This *Canalis*, or Pipe, is of the same Substance and Tincture with a Vein, and enters into the *Cava* just as it penetrates the *Diaphragma*; and there also two other great Branches out of the Liver are inserted into the *Cava*; and in the same Place this Pipe is also knit to the suspensory Ligament, as it is called, and after the Child is born, grows it self into a Ligament, being in a manner opposite to the Umbilical Ligament.

Its Use in the *Fœtus*, is for the freer and readier Motion of the Blood and Chyle out of the Umbilical Vein into the *Cava*, seeing the Current is hardly strong enough to pervade the *Parenchyma* of the Liver; nor indeed is there any Reason why the said Liquors should pass there-through, seeing there is either little or no Bile therein; or however, they are not yet in a Condition to have the same separated from them. But to return to the Divisions of the *Porta*.

The Antients taught, that they were only spread in the sinous or hollow Part of the Liver; but *Dr. Glisson*, in his accurate Anatomy of it, affirms the *Porta* to be dispersed very equally in all its Parts, upper as well as lower.

And whereas it has been a constant Doctrine, That the Branches of the *Porta* open by *Anastomoses*, into those of the *Cava*; the same learned Author, and many others since him, have observed, That there are no such *Anastomoses* at all, but that the Blood doth ouze through the glandulous *Parenchyma* of the Liver, out of the Capillary Veins of the *Porta*, into those of the *Cava*. He that would be fullier informed hereof, may consult his most accurate Book *de Hepate*: But we will now pass to the Branches of the *Porta*, when it is gone out of the Liver.

This Trunk having past a little from the Liver, before it be severed into Branches, puts forth two Twigs, out of its upper and fore-part, which are inserted into the *Cystis fellea*, or Gall-Bladder, (and are from thence called *Cystice gemellæ*) about the Neck of it, and spread by enumerable Twigs through its external Coat.

A third Twig also arises single from it, which is larger than either of the former, and is inserted into the Bottom of the right Side of the Stomach, from whence it ascends by its hinder Side up to the

*Pylorus*.



*Pylorus*, which gives it the Name of *Pylorica*; it is otherwise called, *Gastrica dextra*.

Having sent forth these three Twigs, the Trunk passeth down, and bending a little towards the left Side, it is parted into two remarkable Branches; whereof the upper is called *Sinister*, or the *Left*, and is the lesser; the lower *Dexter* or the *Right*, which is the larger. The *Left* is bestowed upon the Stomach, the *Omentum*, a Part of the *Colon*, and the Spleen; the Right is spread through the Guts and Mesentery; the Left is called, *Vena Splenica*; but the Right *Vena Mesenterica*.

The *Vena Splenica* runs across the Body towards the left Side, being sustained by the hinder Leaf of the Cawl, and hath two Branches issuing out of it, before it comes to the Spleen, viz. the *Superior* and the *Inferior*.

The *Superior* is called *Gastrica*, or *Ventricularis*, because it is bestowed upon the Stomach; it ascends obliquely towards the left Part of the Stomach, into the back Side whereof it is inserted, and divides it self into three Sprigs, of which the two outmost are spent on the Body of the Stomach, but the middle ascends on its back-side up to its upper, or left Orifice, which it encompasses like a Garland, and is called *Coronaria*. From the *Inferior* Branch two Twigs spring; the one is small, and sends Twigs to the right Side of the inner Leaf of the *Omentum*, and to the *Colon* annexed to it. This is called *Epiplois*, or *Omentalis dextra*. The other is spent upon the same Leaf of the *Omentum*, with that Part of the *Colon* which it ties to the Back, and is called *Epiplois*, or *Omentalis postica*.

When the *Ramus Splenicus* hath just approached to the Spleen, it sends out two other Twigs, the upper and lower. The *Upper* is called *Vas breve venosum*, and is implanted into the left Part of the Bottom of the Stomach. It is sometimes single, in which Case it is properly called *Vas breve* in the singular Number; but more often there are two, three, or more of them, and then these Vessels, be they one or more, do sometimes spring from the *Ramus Splenicus*, after it has entered the Spleen.

This *Vas breve* was a Vessel much renowned by the Ancients, who believed it carried an acid Juice from the Spleen to the Stomach, to stir up Appetite, and to help the Fermentation of the Meat in it; but it is certain both by Ligature (whereby it filleth toward the Stomach, and emptieth toward the Spleen) and also by the general Nature of Veins, whose smaller Branches and Twigs still receive the superfluous Arterial Blood from the Part whereinto they are inserted, and conduct it by the larger Channels towards the Heart: I say, it is certain from hence that this same *Vas breve* carries nothing to the Stomach, but only brings from thence, into the *Ramus Splenicus*, the Remains of the Arterial Blood.

From the lower two Twigs issue.

The first is called *Gastroepiplois sinistra*; this is bestowed upon the left Part of the Bottom of the Stomach, and the Fore-leaf of the *Omentum*, chiefly on its left Part.

The second springeth most commonly indeed from the *Ramus Splenicus*, but sometimes from the left Mesenterick Vein; and running along the *Intestinum Rectum*, is inserted into the *Anus*, by many Twigs. This is called *Hæmorrhoidalis interna*, as that which springeth from the *Vena Cava* is called *Hæmorrhoidalis externa*.

Now followeth the *Vena Mesenterica*, or the right Branch of the *Vena Portæ*. Before it be divided into Branches, it sendeth forth two Twigs.

The first is called *Gastroepiplois dextra*; this is bestowed upon the right Part of the Bottom of the Stomach, and the right Side of the upper Leaf of the Cawl.

The second is called *Intestinalis*, or *Duodena*: It is inserted into the Middle of the *Duodenum*, and the Beginning of the *Jejunum*, and runneth lengthways of them; whence some Capillary Twigs go to the *Pancreas*, and the upper Part of the *Omentum*.

After these Twigs are past from it, it enters by one Trunk into the Mesentery, where presently it is divided into two Branches, to wit, *Mesenterica dextra* and *sinistra*.

*Mesenterica dextra* (placed on the right Side) is double, and sendeth a great Number of Branches to the *Jejunum*, *Ilium*, *Cæcum*, and the right Part of the *Colon*, which ascendeth up by the right Kidney, and runs under the Liver.

It hath fourteen remarkable, though nameless, Branches; and these are afterwards divided into innumerable small Twigs. These are those Veins that are called the *Meseraicks*, whose Branches are supported by the Glandules of the Mesentery, but enter not into them; for the Glands open into the *Venæ Lactææ*.

*Mesenterica sinistra*, passeth thro' the Middle of the Mesentery to that Part of the *Colon* which descendeth from the left Part of the Stomach, and to the *Intestinum Rectum*.

The Use of the *Porta*, before the Circulation of the Blood, and the *Venæ Lactææ* were found out, was taught to be for the carrying of Nourishment to the Intestines and other Parts contained in the *Abdomen*, and also to bring back from the Guts the purer Part of the Chyle to the Liver to make Blood of, and a thicker sæculent Part of it to the Spleen, to be excocted by it into an acid Juice, and then carried to the Stomach by the *Vas breve venosum*, for the exciting of Hunger.

As for this last Opinion, it appears by Ligature, That the *Vas breve* carries its Contents from the Stomach to the *Ramus Splenicus*, and it is nothing but the Blood remaining from the Nutrition of the Stomach (that was brought thither by the Arteries) which is now a conveying back to the Liver, and so to the Heart again in its Circulation.

And as for the *Meseraicks* carrying Nourishment to the Guts, or bringing back Chyle, those Errors have been sufficiently laid open before now. But their true Use is only to bring back to the Liver from the Guts, Cawl, and other Entrails, that Blood which remains after their Nutrition, and which was carried to them by their respective Arteries.

*VENÆ Lactææ*, the *Lactæal Veins*, are so called from the white Colour of the Chyle they carry. These were not discovered as such 'till about the Year 1622. When *Gaspar Asellius* found them out in dissecting a live Dog fed well. Since whom, many others have made more accurate Discoveries of them. They are slender pellucid Vessels, having but a single Coat, and are dispersed in great Numbers thro' the Mesentery, and appointed for carrying the Chyle. Their Rise is from the innermost Membrane of the Intestines, where their Mouths are hid under a kind of spongy Crust, or *Mucus*, thro' which, by the Pression of the Guts the Chyle is strained, and received by the Mouths of those Vessels. From whence they proceed the nearest or readiest way to such Glandules of the Mesentery as are nearest them; but in their Passage many smaller



smaller ones uniting to another, do commonly grow into one large Trunk, and this a pretty way before they insinuate themselves into the Glands they are marching to. But then at their Entrance into the Gland, and sometimes a little before, this Trunk separates again into new Branches more and smaller than the other. And hitherto they bear the Name of *Radicales*, or *Venæ Lactææ primi generis*. After this, out of the Gland there spring again new Capillary ones, which by and by meeting together, make one Trunk again, as before, which keeping its Course towards the Centre of the Mesentery, enters as many Glands as lie in its way, being divided into new Branches just before its Entrance into each Gland, as before: But whilst all the Trunks bend one way, they also meeting with one another, do in Process several of them grow into one; and at length all the Trunks arrive at the great or middle Gland of the Mesentery (called improperly *Pancreas*) which most of them enter into, but some of them pass over its Surface, and by and by they all empty themselves into the great or common Receptacle of the Chyle that lies behind the said Gland; those that were inserted into it rising out of it in like manner, as they did before out of the lesser Glands. As they run from one Gland to another, they are called *secundi generis*, or of the second Kind; and from their having passed all the Glands to their opening into the common Receptacle, &c. they are called *tertii generis*, or of the third Kind.

**VENA PENUMONICA**; is a small Vein which creeps along upon the *Bronchia* of the *Astera Arteria*, or *Trachæa* in the Lungs; 'tis described and so called by *Sommichellius*.

**VENÆ Lymphaticæ**, the *Lymphatick Veins*, receive the *Lympha* from the conglobated Glandules, and discharge themselves either into the Sanguinary Veins, or into the Receptacle of the Chyle.

**VENÆ Preputii**, are Veins arising from the Capillary Extremities of the Artery of the *Penis* called *Pudenda*, these uniting into larger Branches, pass into those Veins which arise from the *Corpora Cavernosa Penis*, and passing under the common Integuments, do empty themselves into the upper Vein of that continued from the *Saphena Vein* of the Foot. *Cowper's Myst. Reformata in Append.*

**VENÆ Sectio**, is the same with *Phlebotomy*, or Blood-letting.

**VENAL**, } in *Anatomy*, of or pertaining to  
**VENOUS**, } a Vein or Veins.

**VENDEE**, in *Law*, the Person to whom any thing is Sold; in contradistinction to *Vender*, i. e. the Seller.

**VENDITIONI exponas**, is a Writ Judicial, directed to the Under-Sheriff, commanding him to sell Goods which he hath formerly by Commandment taken into his Hands, for the satisfying a Judgment given in the King's Court.

**VENEREAL**, *Venereus*, L. appertaining to *Venus* or *Venery*.

**VENEREAL Disease**, *Lues Venerea*, L. a contagious Disease, contracted by some impure Humour, generally received in Coition, and discovering itself in Ulcers and Pains about the Genital, and other Parts, the Pox.

**VENERIS Oestrum**, the utmost ecstasy of Desire or Enjoyment in Coition.

**VENIRE facias**, is a Writ Judicial directed to the Under-Sheriff, and goeth out of the Record, and lies where two Parties plead and come to Issue; for then the Party, Plaintiff, or Defendant, shall

have this Writ directed to the Sheriff to cause Twelve Men of the same Country to say the Truth upon the Issue taken. And if this Inquest come not at the Day of the Writ returned, then shall go a *Habeas Corpora*, and after a Distress, until they come. And it is also a Process upon an *Audita Querela*, or upon an Indictment in the King's Bench, or *Venire facias ad computandum*, against Tenant, by *Elegit*.

**VENIRE facias tot Matronas**: See *Ventre inspiciendo*.

**VENT**, a little Aperture left in the Tubes or Pipes of Fountains to facilitate the Escape of the Wind; or on occasion to give them Air; as in frosty Weather, &c. for want of which they are apt to burst a Spiracle or Vent-hole.

**VENT**, with *Chymists*, a Cover of a Wind-Furnace, by which the Air enters, which serves for Bellows, which is stop'd with a Register or Slice, according to the degree of Heat that is required.

**VENT**, in *Gunnery*, signifies the Difference between the Diameter of a Bullet, and the Diameter of the Bore of the Piece; and it ought to be  $\frac{1}{25}$  of the Diameter of the Bore: See *Ordnance*.

**VENTER**, in *Anatomy*, a Cavity in the Body of an Animal that contains the *Viscera* or other Organs, which are necessary for the Performance of divers Functions.

**VENTER Infimus**: See *Hypogastrium*.

**VENTERS**, according to the Definition of Anatomists, are the three principal Cavities, or hollow Parts of Animal Bodies, viz. those of the *Belly*, *Chest* and *Head*; or the *Abdomen*, the *Thorax*, and the *Caput*.

**VENTER**, of a *Muscle*, in *Anatomy*, is the Body or fleshy Part of it, in contradistinction to the two Tendons, the Extremes of it; the one of which is called the *Head*, and the other the *Tail* of the Muscle.

**VENTER Draconis**, in *Astronomy*, the *Dragon's Belly*, is the middle of a Planet's Orbit, or that part which is most remote from the Nodes, i. e. from the *Dragon's Head* and *Tail*. L.

**VENTER Equinus**, in *Chymistry*, i. e. a Horse's Belly, is a Dung-hil, wherein they inclose certain Vessels for particular Operations, which are to be performed by means of the gentle Heat of the Dung.

**VENTER**, in *Law*, is used for a Wife, as a Son by the second *Venter*, i. e. by the second Wife; also for the Child itself.

**VENTIDUCTS**, of *Ventus* and *Ductus*, are Spiracles or subterraneous Places, where fresh cool Winds being contained, are caused to communicate by means of Ducts, Funnels or Vaults, with the Apartments of a House, to render them cool in hot sultry Weather.

**VENTOSE**, a *Cupping-Glass*: See *Cucurbitula*. The Ingenious Mr. *Hawksbee* hath now found a way of applying Cupping-glasses without Fire, by means of a small Air-pump, which does mighty well, and puts the Patient to no Pain or Fright.

**VENTRE Inspiciendo**, is a Writ for the Search of a Woman that saith she is with Child, and thereby withholdeth Land from him that is next Heir at Law.

**VENTRES**: See *Cavitates*.

**VENTRICLE**, the *Stomach*, is a Membranous Bowel in the *Abdomen*, under the *Diaphragma*, betwixt the Liver and the Spleen, consisting of four Tunicks; a Nervous, Fibrous, Glandulous, and Membranous one: It hath two Orifices, one on the



the Right-hand, called *Pylorus* and *Junitor*, whereat the Meat is sent out into the Guts: Another on the Left-hand, at which the Meat enters. Its Office is to concoct or ferment the Meat: It is also called *Stomachus* and *Aqualiculus*.

VENTRICULI *cerebri*, the Ventricles of the Brain, are four; the Use of them is to receive the Serous Humours, and to bring them by the *Pelvis* into the *Pituitary Glandule*, or in the *Processus Mamillares*, by the *Os Cribriforme* to the Nostrils. They are nothing but Complications of the Brain, which happen there as it were by Accident. *Blanchard*.

VENTRICULI *Cordis*, the Ventricles of the Heart, are two: The first, or Right Ventricle, receives the Blood from the *Vena Cava*, and sends it to the Lungs; the Left Ventricle receives the Blood from the Lungs, and sends it through the whole Body by the *Aorta*, or great Artery, and its Branches: In the *Systole*, or Contraction of the Ventricles, the Blood is sent out: In the *Diastole*, or Dilation, it is let into the Heart.

VENTRICULUS, the Stomach or *Ventriculus*, is placed immediately under the Midriff; the Liver covers part of its Right-side, and the Spleen touches it on its Left, and the *Colon* at its bottom; to which also the Cawl is tied. Its figure is like that of a *Scotch Bag-pipe*, being long, large, wide, and pretty round at the bottom, but shorter and less convex on its upper Part, where its two Orifices are. The left Orifice is called *Cardia*; to it the *Oesophagus* is joined, and by it the Aliments enter the Stomach, where being digested, they ascend obliquely to the *Pylorus* or right Orifice, which is united to the first of the Intestines. At this Orifice the Tunicks of the Stomach are much thicker than they are any where else, and the inmost hath a thick and strong Duplicature in form of a Ring, which serves as a Valve to the *Pylorus*, when it contracts and shuts.

The Stomach is made of four Membranes or Coats. The first and inmost is made of short Fibres, which stand perpendicularly upon the Fibres of the next Coat; they are to be seen plainly towards the *Pylorus*. When the Stomach is distended with Meat, these Fibres become thick and short; whilst they endeavour to restore themselves by their natural Elasticity, they contract the Cavity of the Stomach, for the Attrition and Expulsion of the Aliments. This Coat is much larger than the rest, being full of Plaits and Wrinkles, and chiefly about the *Pylorus*. These Plaits retard the Chyle, that it runs not out of the Stomach before it be sufficiently digested. In this Coat there are also a great Number of small Glands, which separate a Liquor which besmeares all the Cavity of the Stomach; therefore this Coat is called *Tunica Glandulosa*.

The Second is much finer and thinner; it is altogether Nervous; it is of an exquisite Sense, and is called *Nervosa*.

The Third is Muscular, being made of straight and circular Fibres; the straight run upon the upper part of the Stomach, between its superiour and inferiour Orifices; and the circular run obliquely from the upper part of the Stomach to the bottom. These Fibres, by their Contraction and continual Motion, help the Attrition and Digestion of the Aliments.

The Fourth Tunicle is common; it comes from the *Peritonæum*.

The Stomach receives Veins from the *Porta*, viz. the *Gastrica*, *Pylorica*, and *Vas Breve*, and Branches

from the *Gastroepiplois dextra & sinistra*, which are accompanied with Branches of the *Arteria Cœliaca*, all which lie immediately under the fourth Coat of the Stomach.

The Eighth Pair of Nerves, or *Par Vagum*, gives two considerable Branches to the Stomach, which descending by the sides of the Gullet, divide each into two Branches, the external and internal. The two external Branches unite in one, and the internal do so likewise; both which piercing the Midriff, form, by a great Number of small Twigs, upon the upper Orifice of the Stomach, a *Plexus*: and then the internal Branch spreads it self down to the bottom of the Stomach; and the external Branch spreads it self upon the inside, about the upper Orifice of the Stomach. This great Number of Nerves which is about the upper Orifice, renders it very sensible, and from them also proceeds the great Sympathy betwixt the Stomach, Head and Heart; upon which account *Van Helmont* thought that the Soul had its seat in the upper Orifice of the Stomach.

The *Plexus Nervosus* of the *Hypochondria* and *Mesenterium*, give several Branches to the bottom of the Stomach; therefore in Hysterick and Hypochondriack Passions, the Stomach is also affected.

The Use of the Stomach is Digestion, which is the Dissolution or Separation of the Aliments into such minute Parts, as are fit to enter our Lacteal Vessels, and circulate with the Mass of Blood: Or it is the simple breaking of the Cohæsion of all the little *Moleculæ*, which compose the Substances we feed upon. Now the Principal Agents employed in this Action, are, first, the *Saliva*, the *Succus* of the Glands in the Stomach, and the Liquors we drink, whose chief Property is to soften the Aliments, as they are Fluids, which easily enter the Pores of most Bodies, and swelling them, break their most intimate Cohæsions. When the Aliments are thus prepared, their Parts are soon separated from one another, and dissolved into a Fluid, with the Liquors in the Stomach, by the continual Motion of its Sides, whose Power in this Action, is, by that great Improver of the true Theory of *Physick*, the learned *Pitcairne*, demonstrated to be equal to the Pressure of 12951 Pound weight: To which if we add the Force of the *Diaphragma*, and the Muscles of the *Abdomen*, which likewise conduce to Digestion, the Sum will amount to 261086 Pound weight. These two Actions we see more clearly in Birds, because they are performed in two Stomachs. In the first the Corn is only swelled and softened by the Liquor of its Glands, but broken and dissolved in the second, which is composed of very strong Muscles, because those of the *Abdomen* and *Diaphragma* are weak, neither do they act upon the Stomach, as in Men. *Keil's Anatomy*.

VENUE, or *Venew*, or *Visue*, are Terms used in Law, signifying the Place next to that where any thing that comes to be tried happened to be done: And therefore for the better Discovery of the Truth of the Matter in Fact upon every Trial, some of the Jury must be of the same Hundred, or sometimes of the same Parish, or Neighbourhood, in which the thing is supposed to be done, who by Intendment may have the best Knowledge of the Matter.

VENUS. The Time of the Periodical Revolution of this Planet round the Sun, is 224 Days and  $\frac{2}{3}$  of a Day, or  $7\frac{1}{2}$  of our Months.



According to Mr. *Cassini*, the greatest Distance of *Venus* from the *Earth* is 38415; the mean Distance 22000, and the least Distance 5585 Semi-diameters of the *Earth*.

And the Diameter of *Venus* is equal to 7 Semi-diameters of the *Earth*; therefore the Globe of *Venus* must be near 43 times greater than that of the *Earth*. But Dr. *Gregory* saith, that to an Eye placed in *Venus*, the Sun's Diameter would appear once and  $\frac{1}{2}$  as big again as it doth to us, and therefore his Disk will be more than double of what it appears to us: And the *Light* and *Heat* in this Planet, and its Gravity towards the Sun, will be in the same Proportion in respect of ours.

The Length of the Day in *Venus*, is but 23 Hours.

The Eye here will behold 4 Planets above it, viz. our *Earth*, *Mars*, *Jupiter* and *Saturn*; and one below it, which is *Mercury*: And when our *Earth* is in Opposition to the Sun, it will appear then (in the Night) to shine with a full Orb, and be very bright. The Moon will appear always to accompany the *Earth*, and never to be seen from her above  $\frac{1}{2}$  a Degree. *Mercury* will never appear to be above 38 Degrees distant from the Sun.

*Kepler* saith, the Inclination of the Orbit of *Venus*, is 3 Degrees and 22 Minutes.

October  $\frac{1}{4}$  1666, *Cassini* observed several Spots in the Body of this Planet, by whose Motion he judged (tho' he was not certain) that she moved either by a Circulation, or a kind of Libration round her Axis, in about 23 Hours.

A. D. 1672, and 1686, the same Astronomer, with a Telescope of 34 Foot, believes he saw a *Satellite* moving round this Planet, and distant from it about  $\frac{1}{2}$  of *Venus*'s Diameter. It had the same Phasis with *Venus*, but was without any well defined Form, and its Diameter scarce exceeded  $\frac{1}{4}$  of that of *Venus*.

Dr. *Gregory* thinks it more than probable, that this was a *Satellite*; and supposes the Reason why it is not usually seen, to be the Unfitness of its Surface to reflect the Rays of the Sun's Light; as is the case of the Spots in the Moon, of which if the whole Disk of the Moon were composed, he thinks that the Planet could not be seen in *Venus*'s *Astrol.* & *Geom.* p. 472.

*Herigone*, *Kepler*, and *Rhætensis*, or *Schylnæus de Rhætis*, conjecture that *Venus* moves round her Axis in about 14 Hours; as *Kircher* and *Schiottus* pretend to have discovered, by Observation of certain Spots in her.

VENUS, in *Chymistry*, Copper, the Character of which is ♀, which the Adepts say, expresses it to be Gold, only joined with some corrosive or arsenical *Menstruum*, which if it were removed, Copper would be Gold.

VERB, in *Grammar*, is a variable Part of Speech, expressing the Action of the Mind, which affirms that a Thing is so, or not so: And 'tis either *Personal*, which is conjugated or formed through all the three Persons; or *Impersonal*, which is only found in the third Person Singular.

VERBERATION, in *Physicks*, a Term used to express the Cause of Sound, which arises from the *Verberatum* of the Air, when struck in divers manners by the several Parts of the sonorous Body first put into a vibratory Motion.

VERDEGREASE, is the Rust of Copper gathered by stratifying Plates of Copper with the Husks of pressed Grapes, and then scraping off the Rust of the Plates contracted by lying in those

Husks for some time. But the Painters call *Verdegrease*, or *Verdeter*, a kind of Magistery of the common Verdegrease; which is dissolved in distilled Vinegar, and then Crystaliz'd in a cool Place. These are called Crystals of *Venus*, made by Vinegar.

VERDEROR, is a Judicial Officer of the King's Forest, chosen by the King's Writ in the full County of the same Shire where the Forest is; and is sworn to maintain and keep the Assizes of the Forest; to view, receive and enrol the Attachments and Presentments of all manner of Trespassies of Vert and Venison in the Forest.

VERDICT, is the Answer of a Jury made upon any Cause, Civil or Criminal, committed by the Court to their Examination. And it is either *General* or *Special*: A *General Verdict*, is that which is given or brought into the Court in like general Terms, to the general Issue, as in Action of Disseisin, the Defendant pleadeth, *No Wrong, no Disseisin*; then the Issue is *General*, whether the Fact be wrong, or not; which being committed to the Jury, they, upon Consideration of their Evidence, come in, and say, either for the Plaintiff, that it is a Wrong and Disseisin; or for the Defendant, that it is no Wrong, no Disseisin. A *Special Verdict* is, when they say at large, that such a Thing, and such a Thing, they found to be done by the Defendant or Tenant, so declaring the Course of the Fact, as in their Opinion it is proved; and as to the Law upon the Fact, they pray the Judgment of the Court. And this *Special Verdict*, if it contain any ample Declaration of the Cause from the Beginning to the End, is also called a *Verdict at large*.

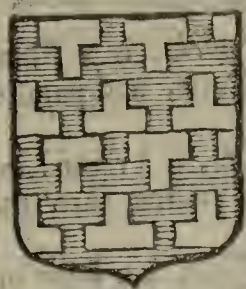
VERDITER, is made thus: Into an hundred Pound weight of Whiting put into a Tub, the Refiners pour their *Copper Water*, (see *Refining*) and stir them together every Day for some Hours together, till the Water grows pale: Then they pour that away, and set it by for further Use, and pour on more of the green Water, and so continue till the *Verditer* be made; which being taken out, is laid on large Pieces of Chalk in the Sun, till it be dry for the Market. The Water mentioned to be drawn or poured off from the *Verditer* (which remains at the Bottom of the Tub) is put into a Copper and boiled, till it come to the Thickness of Water Gruel, now consisting principally of Salt-Petre reduced, most of the Spirit of Vitriol being gone with the Copper into the *Verditer*; and a Dish full of this being put into the other Materials for *Aqua-Fortis*, is re-distill'd, and makes what they call a *Double Water*, which is near twice as good as that made without it. *Phil. Transf.* N<sup>o</sup> 142.

VERDOY; a Term in Heraldry for a Bordure of a Coat of Arms, being charged with any Kinds or Parts of Flowers, Fruits, Seeds, Plants, &c.

VERGE, is the Compass of the King's Court, which bounds the Jurisdiction of the Lord-Steward of the King's Household, and of the Coroner of the King's House; and that seems to have been twelve Miles round.

*Verge*, is also used for a Stick or Rod, by which One is admitted Tenant, and holding it in his Hand, takes the Oath of Fealty to the Lord of the Manor, and for that cause is called *Tenant by the Verge*. Also the Spindle of the Balance of a Watch is called the *Verge*.





VERGETTE, in *Heraldry*, is what, by the *English* *Heralds*, is called a Pallet, or small Pale.

VERGILLÆ, in *Astronomy*, a Constellation; the Appearance of which intimates the Approach of the Spring.

VERMICULAR *Work*, in *Sculpture*, a Sort of Ornament used in Rustick Work, which consists of Frets or Knobs cut with Points, in some sort representing the Tracts made by Worms.

VERMICULARES: See *Lumbricales*.

VERMICULATION, is an Infection of Plants by Worms.

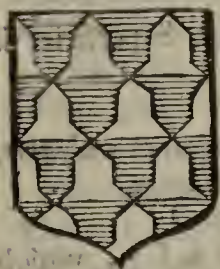
VERMIFORMIS *Processus*, is the Prominence of the *Cerebellum*, so called from its Shape.

VERMINATION, with *Physicians*, the Wringing of the Guts, wherein the Patient is affected, as if Worms were gnawing his Intestines.

VERMIVOROUS, are such Animals as feed upon Worms.

VERNAL Signs, in *Astronomy*, those Signs in which the Sun is during the Spring Season, viz. *Aries*, *Taurus*, and *Gemini*.

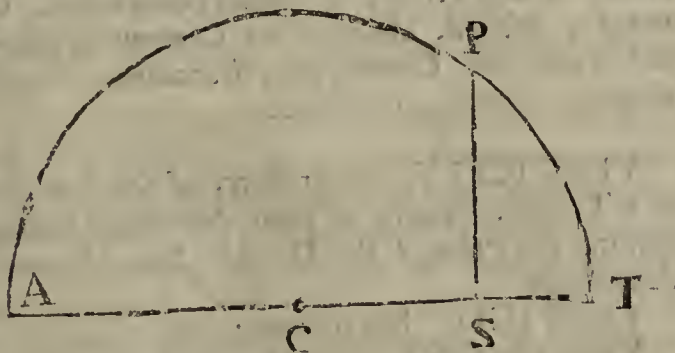
VERNAL Equinox, in *Astronomy*, that Equinox that is when the Sun is ascending from the Equator towards the North.



VERRY, or *Vairy*, in *Heraldry*, is of two Sorts. If the Colours (which is a sort of Chequer-Work, of the Shape of little Bells) be Argent and Azure, 'tis enough to say *Vairy* alone: But if the Colours are any other, they must be named expressly. They engrave it thus.

VERSED-Sine, of an Arch, is a Segment of the Diameter of a Circle, lying between the Foot of the Right-Sine, and the lower Extremity of the Ark: See more under the Word *Trigonometry*.

Thus ST is the Versed-Sine of the Ark RT; and AS the Versed-Sine of the Ark AR, which is the Supplement of the former.

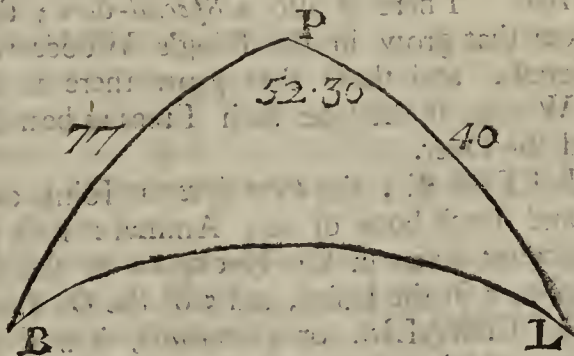


VERSED-Sine; what it is, see under *Trigonometry* and *Scale*, as well as under *Versed-Sine*.

From the Radius or Sine of any Ark, to find the Versed-Sine.

If the Ark be less than  $90^\circ$ . the Co-sine taken out of the Radius leaves the Versed-Sine: But if the Ark be greater than a Quadrant, the Radius added to the Co-sine makes the Versed-Sine. By the Sector, the Distance from  $90$  to  $80$  on the Line of Sines taken laterally, is the Versed-Sine of  $10^\circ$ : The Distance between  $90$  and  $70$ , the Versed-Sine of  $20^\circ$ , &c. But if the Right-Sine were  $50^\circ$ . and you would have the Versed-Sine of  $50^\circ$ . make a parallel Entrance of the Sine given between  $50$  and  $50$  in the Lines of Sines; and by that means, the Distance between  $90$  and  $90$ , will give the Length of the Radius: Then out of that Radius take parallelly found the Sine of  $40^\circ$ , (the Co-sine of  $50^\circ$ .) the Remainder will be the Versed-Sine  $50^\circ$ .

In Sir *Jonas Moor's New System of Mathem.* Vol. II. in the New Book of *Logarithms* (and in some other Books) you have *Tables of Versed-Sines*, both natural and artificial, whose Uses are very many; and especially in solving some of the most useful Cases of Spherick Triangles: As in calculating the Distances of Places on the Earth's Surface, according to the Arch of a Great Circle, by having their Longitudes and Latitudes; The Distances of two Stars, by having their Right Ascensions and Declinations, or their Longitudes and Latitudes; by which means, the Altitudes of two Stars not on the Meridian, or of the Sun, with the Difference of Time or Azimuth being observed, the Latitudes of Places may be found.



As in the Spherick Triangle BPL, let the Legs BP and PL be given, and the contained Angle BPL. To find the Side BL.

I say, as the Cube of Radius, to the Rectangle of the Sines of the Legs; so is the Square of half the Sine of the contained Angle, to half the Difference of the Versed-Sine of the third Side, and of the Ark of Difference between the two containing Sides.

Therefore, in Practice, double the Logarithmick Sine of half the Angle given, and to it add the Log. Sines of the Legs; and from the Left-hand of the Sum, strike out 3 for the Cube of the Radius, there will remain the Logarithm of half the Difference of those two Versed-Sines.

Which half Difference doubled, and added to the Versed-Sine of the Difference of the Legs, gives the Versed-Sine of the Side sought.



## E X A M P L E.

The Log. Sine of  $40^{\circ}$  - 9.8080675  
 The Log. Sine of  $77^{\circ}$  - 9.9887239  
 The Log. Sine of  $26^{\circ}$  } 19.2914116  
 15 when doubled }

The natural Sine against 39.0882030 is 1227355

Whose Double is 2454710  
 The natural Versed-Sine of  $37^{\circ}$  the } 2013645  
 Difference of the Legs, is }

Their Sum is 4468355

Which is the Versed-Sine of 57 deg. 53 min. the Side required or sought.



VERT; the Heralds Word for a Green Colour; and 'tis called Vert in the Blazon of the Coats of all under the Degree of Noble: But in Coats of Nobles 'tis called *Emerald*; and in those of King's 'tis called *Venus*. In Engraving 'tis expressed by Lines drawn athwart, beginning at the Sinister Corner of the Escutcheon, thus.

VERT, in the Forest-Law, signifies every thing that grows and bears a green Leaf within the Forest, that may cover a Deer. And 'tis either *Over-vert* or *Nether-vert*: *Over-vert* is the great Woods, and in Law-Books are usually called *Hault-Bois*: *Nether-vert* is the under Woods, otherwise call'd *South-Bois*. There is also a *Special-vert*; that is, all Trees that grow in the King's Woods within the Forest; and those that grow there in other Mens Woods, if they be such Trees as bear Fruit to feed the Deer.

VERTEBRÆ; the *Vertebres* or Joints of the Neck and Back bone of any Animal: In a Man they account seven in the Neck, 12 in the Back or *Dorsum*, 5 in the Loins, and 5 of the *Os Sacrum*.

VERTEBRALIS, or *Cervicalis*, is a Pair of Muscles, which extend all the *Vertebrae* of the Body.

VERTEX, is that Point in the Heaven just over our Heads, and the same with *Zenith*; which see.

The Point of any Angle is called also its *Vertex*; and that the Point of the Curve of a Conick Section, where the Axis cuts it, is called also the *Vertex* of that Section.

VERTEX, in Anatomy, is also the Crown of the Head, or the middle Part of it, seated between the Bounds of the *Sinciput* and *Occiput*.

VERTEX of a Cone, Pyramid, Conick Section, &c. is the Point of the upper Extremity of the Axis, or the Top of the Figure. So the *Vertex* of an Angle, is the Angular Point; and those Angles which, being opposite to one another, do touch only in the Angular Point, are called *Vertical* Angles.

VERTEX of a Glass (in Opticks) is the same with its Pole; which see.

VERTICAL Circles: See *Azimuths*.

VERTICAL Line: See *Line Vertical*.

VERTICAL opposite Angles: See *Angles*.

VERTICAL Plain in Perspective: See *Plain*.

VERTICAL Point, the same with *Vertex*: So that in Astronomy, a Star is said to be *Vertical*,

when it happens to be in that Point which is just over any Place.

VERTICAL-PLANE, in *Conicks*, is a Plane passing thro' the Vertex of the Cone, and parallel to any Conick Section.

VERTICAL-LINE, in *Conicks*, is a right Line drawn on the Vertical-Plane, and passing thro' the Vertex of the Cone.

VERTICAL-LINE, in *Dialling*, is a Line on any Plane perpendicular to the Horizon; this is best found and drawn on an erect or reclining Plane, by holding up a String and heavy Plummet steadily, and then marking two Points of the Shadow of the Thread on the Plane, a good Distance from one another, and then drawing a Line thro' those Marks.

VERTICILLATE Plants, are by the Botanists said to be such as have their Flowers intermixed with small Leaves, growing in kinds of *Whirls* about the Joints of the Stalk, as *Penny-Royal*, *Hore-bound*, &c. See *Plants*.

The peculiar Characteristicks of this Genus of Plants, Mr. Ray saith, are, their Leaves growing by Pairs, one just against another on the Stalk. The Flower *monopetalous*, but usually hanging down with a kind of a Lip, or turn'd something like the Form of an Helmet, four Seeds after each Flower, to which the *Perianthium* of the Flower serves instead of a *Capsula Seminalis*.

Mr. Ray makes two kinds of these *Verticillate* Plants.

I. The *Fruticosæ*, or such whose Superficies is Perennial; and these have either,

1. A plain Flower, as the *Chamædrys vulgaris*, *Thucrium*, and the *Marum Syriacum*.

2. Such as have a Flower with a Lip, which they call a *labiated* Flower, or one something in the Form of a Helmet, which they call *galeated*; as the *Sacria Stæchas*, *Hyssopus*, *Rosmarinus*, *Satureia*, *Marum vulgare*, *Thymum vulgare*, and the *Polium montanum*.

II. The *Verticillatæ Herbacææ*, or such whose Stalks are not perennial; and these are the *Mentha*, *Verbena*, *Diſtamnus Creticus*, *Origanum*, *Majorana*, *Ocimum*, *Horminum*, *Galeopsis*, *Nepeta*, *Betonica*, *Prunella*, *Stachys*, *Clinopodium vulgare*, *Lamium*, *Molucca Hedera terrestris*, *Galericulata*, *Calamintha*, *Melissa*, *Marrubium Commune*, *Nigrum*, and *Aquaticum*, *Chamæpetys*, *Scarodonia*, *Scordium*, *Bugula*, *Syderitis*, *Cardiaca*.

VERTICITY, the Property of the Loadstone, or a Touch'd-Needle to point *North* and *South*, or towards the Poles of the World: See *Magnet* and *Magnetism*.

VERTIGO: See *Scotomia*.

VERO-MONTANUM, in *Anatomy*, a kind of Valve in the Place where the Ejaculatory Ducts enter; the Use of it is to prevent the Urine in passing the *Urethra* from getting in at those Ducts, and so mixing with the *Semen*, L.

VERU, a Comet, according to some Writers, resembling a Spit, being nearly the same kind as the *Lonchites*, only its Head is rounder, and its Train longer and sharper pointed.

VERY



VERY LORD, and *Very Tenant*, are Terms in Law, signifying those that be immediate *Lord* and *Tenant* one to another.

VESICA: So the Chymists call the large Copper Body tinned within side, which is commonly used in Distillation of Ardent Spirits, because 'tis in Figure something like a blown Bladder. This is called also a *Cucurbit*, and commonly, a *Body*: See its Figure in *Cucurbite*.

VESICA *Urinaria*, the *Bladder*, is a Vessel appointed to receive the Urine separated in the Kidneys; and brought to it by the Ureters.

It is seated in the *Hypogastrium*, betwixt the two Coats of the *Peritonæum*, in that Cavity that is formed of the *Os Sacrum*, *Coxæ* and *Pubis*, and is called *Pelvis*. In Men it lies upon the *Intestinum rectum*; in Women it adheres to the Neck of the Womb, which is placed betwixt the Bladder and the streight Gut: In both it is knit before to the *Ossa Pubis*. Moreover, it is knit to the Navel by the *Urethra*.

Its Substance is made up of three Membranes.

The first and outmost is borrowed from the *Peritonæum*. *Riolanus* says, This Coat is a Duplication of the *Peritonæum*, within which the Bladder lies hid, suspended like a Bottle turned the Mouth downwards. On its Outside, in Man, it is besmear'd with Fat, but not in Beasts.

The second is thicker, and endowed with car-nous Fibres; yea, *Aquapendens*, *Spigelius*, *Walæus*, and *Bartholin*, will have it to be a true Muscle, serving for the Compression of the Bladder, to squeeze out the Urine; as the Sphincter serveth for Constriction to retain it.

The third and innermost, is white and bright, of exquisite Sense, as those know too well who are troubled with the Stone.

Within it is covered with a slippery mucous Humour, such as the Gall-bladder has on its Inside, and such as the Intestines abound with, which, without Doubt, must be spued out of some Glands in this inmost Coat, tho' they be hardly discernable. This doth defend it from the Acrimony of the Urine.

Its Membranes hath all Sorts of Fibres. And when these Membranes and Fibres are too long or too far extended with Plenty of Urine, they lose the Power of contracting themselves, whence there issues a Stoppage of Urine.

It is perforated in three Parts, *viz.* in the Sides, where the Ureters are inserted, to let in the Urine; and before at its Neck, to let it out.

It hath two Parts, to wit, the Bottom, and the Neck.

The *Bottom* comprehends the upper, wider and more membranous Part of the Bladder, to which the *Urachus* being tied, reaches the Navel, which together with the bordering Umbilical Arteries, become a strong Ligament in the Adult, hindering the Bladder to press upon the Neck. But as for the Arteries, *Riolanus in Animadv. ad Bauch.* affirms, That they contribute nothing to the Suspension of the Bladder, neither reaching to the Navel in the Adult, nor touching the Body of the Bladder of the *Urachus*.

The *Neck* is lower than the Bottom, thicker and straiter. In Men, it is longer and narrower, and being carried to the Rife of the *Penis*, opens into the *Urethra*; in Women it is shorter and

wider, and is implanted into the upper Side of the *Vagina* or the Womb: In both it is car-nous and muscular, woven of very many Fibres, especially transverse or orbicular, which lie hid within the streight Fibres that surround the whole Body of the Bladder, and these make the Sphincter, which constricts the Neck of the Bladder so, as no Urine can pass out against one's Will, unless when it is affected with the Palsy, Ulcer, or other Malady, by which there sometimes happens an involuntary Pissing.

The Bladder is oblong and round, in Shape like unto a Pear.

Its *Cavity* is but one ordinarily, yet sometimes it has been found to have a membranous Partition, that divides it into two, which yet had a Hole in it for the Communication of one Cavity with the other. Such a Partition was observed in the Bladder of the Great *Casaubon*.

It hath *Arteries* and *Veins* from the *Hypogastrica*, which are inserted into the Sides of its Neck, where they are immediately branched into two, whereof one is spent upon the Neck, and the other on the Bottom. *Nerves* it hath (according to Dr. *Willis*) from the lowest *Plexus* of the Intercostals in the *Abdomen*, and from the Marrow of the *Os Sacrum*. For the said *Plexus* sending two Nerves into the *Pelvis*, they have each of them a vertebral Nerve joined to them, and so make two new *Plexus*, from one of which there passes a Nerve, that being divided into many Branches, is on each Side distributed into the Bladder, and its *Sphincter Muscle*.

The Use of the Bladder is to receive the Urine from the Ureters, and to contain it like a Chamber-pot, until the Time of Excretion, when it is squeez'd out of it by the Help partly of its own car-nous Membrane, and partly of the Muscles of the *Abdomen*.

*Bartholin* quotes some Observations of *Borrichius*, concerning the Bladder, worthy to be noted, *viz.* "If it be boil'd in Acids, it turns into a Mucilage; "if it be in salt Liquors, it is thickned; if in Oleous, or in the Liquor of the Alkali Salts of Tartar, or Herbs burnt to Ashes, it is neither thickned, nor turns into a Mucilage, but is burnt, as "if it were laid on burning Coals, and may almost be crumbled to Powder. By which (says he) it appears, with what great Danger to the "Bladder, Men inject into it either acid, salt, or "oleous Liquor, to break the Stone.

VESICATORIA, are Medicines which act upon, and rarify the Spirits and serous Particles, gather themselves betwixt the Skin and *Cuticula*, and consequently separate them, and raise little Bladders full of serous Matter, which are called *Blisters*.

VESICULA *Fellis*: See *Folliculus Fellis*.

VESICULÆ *Seminales*, the Seed-Bladders, are little Cells like those in a Pomgranate, or somewhat resembling a Bunch of Grapes. *De Graef* compares them to the Guts of a little Bird variously contorted.

They consist of one thin Membrane, through which some small Twigs of both Veins, Arteries, and Nerves run. They are about three Fingers-breadth long, and one broad; but in some Places broader, and some narrower, as they run in and out. They are two (one for each *Vas deferens*) divided from one another by a little Interstice; and



they do severally, by a peculiar Passage, emit the *Semen* contained in them into the *Urethra*.

They are very anfractuons and winding, and (as was said) consist of many little Cells, that they should not pour out all the *Semen* contain'd in them in one Act of Copulation, but might retain it for several. They have no Communication one with another, nor even in their very opening into the *Urethra*; but the *Semen* that is brought to the *Vesiculæ Seminales* on the right Side, by the right *Vas deferens*, issues by its proper Passage into the *Urethra*, and that which is brought to the left likewise. So that if by any Accident the *Vesiculæ* on one Side be burst or cut (as in Cutting for the Stone they generally are) yet those on the other, being entire, may still suffice for Generation. Now when the *Semen* is emitted out of these *Vesiculæ* in the Act of Generation, it passes out the same way it came in, which in this case may easily be (tho' otherwise it be unusual there should be a contrary Motion of the same Vessel) for, as it comes in from the *Vasa deferentia*, it drills along gently, without any Force; but in *Coitu*, when the Muscles of the *Penis*, and all the bordering Parts, are much tumified, it is expressed or squirted out of them with some Violence; and passing along their Neck, (which is a Continuation of the *Vasa deferentia*) ouzes through a Carbuncle (like Quicksilver thro' Leather) into the *Urethra*, or the Duct of the *Penis*, that is common both to the *Semen* and Urine. I say, it ouzes from the Necks of the *Vesiculæ* thro' a Carbuncle into the *Urethra*, for there is one placed as a Valve before the Orifice of each of them, partly to hinder the coming of the Urine into them, partly to hinder the involuntary Effusion of the *Semen*.

Now, though naturally the little Holes through which the *Semen* passes out of the Necks of the *Vesiculæ* into the *Urethra*, be almost imperceptible, yet if they be either eroded by the Acrimony of the *Semen* (such Acrimony as is contracted by impure Embraces, or in Claps, as we call them) or if of themselves they be debilitated, and so become more lax (as sometimes happens) to old or impotent Men that meddle too much, then there happens a *Gonorrhæa* or continual Efflux of *Semen*: And so *Vasalius* and *Sprigelius* have observed them much dilated, in dissecting such as have died with a *Gonorrhæa* upon them.

**VESPERTILIONUM** *alæ*, are two broad membranous Ligaments, on each Side one, where-with the Bottom of the Womb is loosely tied to the Bones of the Flank. *Artæus* likens them to Batwings, whence the Name. *Blanchard*.

**VESPERTINE**, in Astronomy, when a Planet sets after the Sun, it is said by some to be *Vesper-tine*.

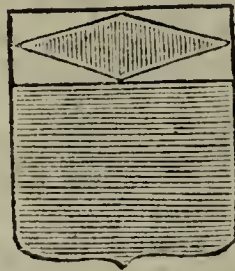
**VESSELS**, in Architecture, are certain Ornaments, usually set over the *Cornices*, and so nam'd, because they represent divers sorts of *Vessels* which were in use among the Ancients.

**VESTIBLE**, in Architecture, a kind of Entry into large Buildings, being an open Place before the Hall, or at the Bottom of the Stair-Case.

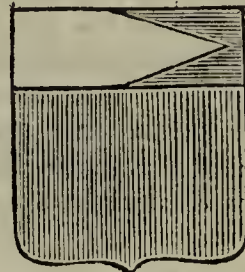
**VESTIBULUM**, is a Cavity in the *Os Petrosum*, behind the *Fenestra Ovalis*; it is covered with a fine Membrane: in it open the semicircular Pipes of the Labyrinth. The upper Turning of the *Cochlea*, and the Auditory Nerve pierce into it also.

**VESTIGIA of Tendons**, are the little Hollows in the Shells of Fishes, which are formed on pur-

pose for the fastening or rooting of the Tendons of their Muscles. These are plainly found on all the Fossile Shells; and this is a Demonstration that once they really belonged to Fishes, and are not formed Stones.



**VESTU**, in Heraldry, is when there is in an Ordinary some Divisions only by Lines, and signifies clothed, as tho' some Garment were laid upon it. See the Escutcheon.



**VESTU a dextra**, with *Heralds*, i. e. clothed on the Right Side, and *Vestu a sinistra*, i. e. clothed on the Left Side, are, as represented in the Escutcheon, and *à contra*.

**VESTURE**, in Law, signifies a Possession or an Admittance to a Possession or Seisin. Thus it is also taken by the *Feudists*, with whom *Investitur* signifies a Delivery of Possession by a Spear or Staff, and *Vestura* Possession it-self.

**VETERNUS**: See *Lethargus*.

**VETITUM namium**. *Namium* is a Distress, and *Vetitum* forbidden: Thus when the Bailiff of a Lord distrains Beasts or Goods, and the Lord forbids his Baliiff to deliver them when the Sheriff comes to replevy them; and to that end, drives them to Places unknown; or when without any Words they are so elained, as they cannot be replevied, divers Lords of Hundreds, and Courts-Barons, have Power to hold Plea *De vetito namio*: See *Naam*.

**VI & armis**, an Expression in a Charge or Indictment, to shew the forcible and violent Commission of any Crime.

**VI Laïca amovenda**, when the Bishop of a Diocess has certified into the Court of *Chancery*, that the Rector or Vicar of any Church within his Jurisdiction is kept out of his Manse, or Glebe, or Church, by any Lay-force or intruding Power; then may a Writ be granted to the Sheriff, to remove all such Violence, and such Usurpation; which Writ is therefore called, *De vi Laïca amovenda*.

**VI Laïca removenda**, is a Writ that lies where Debate is between two Parsons or Provisors for a Church, and one of them enters into it with a great Number of Lay-men, and holds the other out *Vi & Armis*; he that is holden out, shall have this Writ directed to the Sheriff, that he remove the Force. And this Writ is returnable, and shall not be granted until the Bishop of the Diocess, where such Church is, hath certified into the *Chancery* such Resisting and Force.

**VIA Lactea**: See *Milky-way*.

**VIA PRIMÆ**, in Anatomy, the Stomach and Guts, including the whole Length of the alimentary Duct or Canal from the Mouth to the *sphincter Ani*.

**VIBEX**, with Physicians, a black and blue Spot, occasioned by a Flux of Blood.

**VIBRATION**, is the Swing or Motion of a Pendulum, or of a Weight hung by a String on a Pin: See the Proportions of the Vibrations of Pendulums, under *Pendulum*.

**VIBRA-**



**VIBRATING-MOTION**, is a very quick and short Motion of the solid Parts of Bodies, caused by the Pulse or Stroke of some Body upon them. Thus the Rays of Light or Fire striking upon the small Particles of Bodies, do excite in them such Vibrations, and cause them to grow hot and shine. For all fixed solid Bodies, when heated to a due Degree, will emit Light, and shine; and Bodies which abound with *earthy Particles* (as the Chymists speak) and especially sulphureous ones, do emit Light, which way soever their Parts come to be agitated into these *vibrating* Motions, whether by *Heat*, by *Rubbing*, by *Striking*, or by Putrefaction, or some animal or vital Motion. Thus the *Sea-water shines* or *burns*, as they call it, in a Storm; *Quick-silver* emits a Light when shook in *Vacuo*: an Hare's Neck, or Cat's Back, when rubbed with one's Hand in the Dark; Wood, Flesh and Fish, when 'tis rotten and putrefied: So shine Vapours arising from putrid Waters, as the *Ignes Fatui*, &c. Thus kindles wet Hay, &c. thus *Diamonds* rubbed in the dark, emit a Light, like the *Phosphorus*; and thus Iron will grow hot, and burn with quick and forcible hammering on an Anvil.

Of the vibrating Motion of the Parts of solid Bodies, a good Instance also you have in Bells, or the Brims of Drinking-glasses half full of Liquor, and then rubbed strongly with one's Finger a little wetted.

Dr. *Hooke* saith, he hath observed the Direction of this vibrating Motion, to be from the Centre outwards, & *vice versa*.

**VIBRISSÆ**, are the Hairs which grow in the Nostrils: They, with the *Mucus*, which the Glands separate, stop any Filth from ascending too high up into the Nostrils.

**VICAR**; the Priest of every Parish is called *Rector*, unless the *Predial Tythes* be impropriated; and then he is called *Vicar*, *quasi vicem fungens Rectoris*. The *Vicar* is called perpetual, because every Vicarage hath a constant Succession (like a Corporation) and never dies.

**VICARIO** *deliberando occasione cujusdam Recognitionis*, &c. is a Writ that lies for a Spiritual Person imprisoned, upon Forfeiture of a Recognition, without the King's Writ.

**VICENTUM**: See *Venue*.

**VICE-CHAMBERLAIN**, is a great Officer in the King's Court, next under the Lord-Chamberlain; and in his absence hath the Controul and Command of all Officers whatsoever, appertaining to that Part of his Majesty's Household which is called the *Chamber*, or above Stairs.

**VICIS** & *venellis Mundandis*, is a Writ that lies against a Mayor or Bailiff of a Town, &c. for the clear keeping of their Streets.

**VIDIMUS**, in *Law*, the same as *Innotescimus*, being Letters Patent of a Charter of Feoffment or some other Instrument; but not of Record.

**VIEW**, in *Law*, signifies the Act of Viewers; for when an Action real or personal is brought, and the Tenant knows not well what Land it is that the Demandant asks, then he may pray the *View*; which is, that he may see the Land which is claimed.

**VIEW**, of *Frank-pledge*, is the Office which the Sheriff in his County-Court, or the Bailiff in his Hundred, performs in looking to the King's Peace, and seeing that every Man be in some *Pledge*.

**VIGIL**; tho' the Civil Day begins from Midnight, yet the Ecclesiastical or Scriptural Day be-

gins at Six in the Evening, and holds 'till Six in the Evening of the ensuing Day. Hence the *Collect* for every Sunday and Holiday (by Order of our Church) is to be read at the preceding Evening Service, or at the Vespers or Even-song at Six o'clock the Day before; from which Time the Religious Day was supposed to begin: and this first part of the Holiday, from Six o'clock of the Day before, was by the Primitive Christians spent in Hymns, and other Devotions; and these being often continued 'till late in the Night, were thence called *Vigils*. Tho', by degrees, these *Vigils* became so enlarged, that at last all the Day preceding the Holiday, came to be called by this Name, as it is now.

**VILLANIS** *Regis subactis reducendis*, was a Writ that lay for bringing back the King's Bondmen, that had been carried away out of his Mannors to which they belonged.

**VILLAIN**, is the same with Servant or Bondman; and there were formerly in *England* two sorts of these Villains: *Villains in gross*, who were bound immediately to the Persons of their Lords, and to their Heirs; and *Villains Regardent to a Mannor*; these the Civilians call *Glebæ Ascriptitios*; and they were bound to their Lord as Members belonging to such a Mannor of which he was Owner. This latter was a pure *Villain*, of whom the Lord took Redemption to marry his Daughter, and to make him Free; and he might put him out of his Lands and Tenements at his Will; might beat and chastize him, but not maim him. We have now no such Slaves as these.

**VILLAINOUS Judgment**, in *Law*, is a Judgment or Sentence that casts the Reproach and Stain of *Villainy* upon him, against whom it is given.

**VILLENAGE**, signifies a servile kind of Tenure, anciently belonging to Lands or Tenements, whereby the Tenant was bound to do all such Services as the Lord commanded. Of this *Villennage* there are several sorts, but the Slavery of such a Custom is now laid down in *favorem libertatis*; tho' the Statute concerning them be unrepealed.

**VILLI**, in *Botany*, are small Hairs like the Grain of *Plush* or *Shag*, with which, as with a kind of Excrecence, some Trees do abound. Of this kind is the *Usnea Officinarum*.

**VINCULUM**, is a Term in Fluxions, implying that some compound surd Quantity is multiplied into a Fluxion, &c. Thus, in this Expression,  $ax \sqrt{ax - aa}$ , the *Vinculum* is the compound Surd  $\sqrt{ax - aa}$ , which is  $x^d$  into  $ax$ .

**VIRGATE**, or *Yard-Land*, was originally no more than a certain Extent or Compass of Ground, surrounded with such Bounds and Limits; and therefore the Quantity was uncertain, according to the Difference of Places and Customs.

**VINDEMIATRIX**, a fix'd Star of the third Magnitude in the Constellation *Virgo*, whose Longitude is 185 Degrees, 23 Minutes, Latitude 16 Degrees 13 Minutes.

**VINUM Hypocraticum**, is a Wine wherein Sugar and Spices have been infused, and is afterwards strained through a Bag, which they call *Manica Hippocratis*; which see. *Blanchard*.

**VIOL**, a kind of Hawser (in a Ship) made use of to purchase in the Cable, when the Main-Capstan cannot do it, because the Ground in which the Anchor is let fall, is too stiff, or else the Sea runs too high, so that they cannot weigh it; then for more help, they take a Hawser, and opening one Strand thereof, they put therein Nippers (that



is, small Ropes, with a little Trunk at one end) and with these they bind fast this Hawser to the Cable, and then they bring it to the *Jeer-Capstan*, and so heave upon it: And this *Viol* will purchase far more than the Main-Capstan can. This *Viol* is fastned together with an Eye and a Wale-knot, or else with two Eyes seized together.

**VIRGÆ**, is a Meteor, representing a *Bundle of Rods*, and made by the Sun's-beams piercing the more lax and open Parts of a watry Cloud.

**VIRGINS-Milk**, is made by dissolving *Saccharum Saturni* in a great deal of Water: It will turn white as Milk; whence the Name. If the Dissolution be left to settle, the white Matter will precipitate, and may be used as a *Magistery of Saturn*.

**VIRGO**, one of the 12 Signs of the Zodiack, being the 6th according to Order.

**VIRGIN**, in *Grammar*, a Point in Writing, by us call a *Comma*; by the *French*, &c. *Virgula*.

**VIRGULA Divinatoria**, is a Hazle Rod shaped into two Branches like a Y, which must be cut at the time of some certain Planetary Aspect, and by which (as some Writers pretend) you may easily find out a Vein of rich Metal or valuable Ore in the Earth.

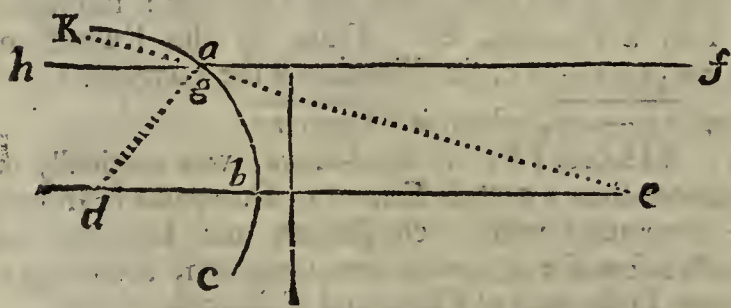
Mr. *Boyle* tells us, that some Authors report the Fact: But I judge we may very reasonably suspect, if not deny the Truth of the Relation, for all this; for he himself owns he could never find any thing in it: And so saith *Kircher*, tho' a Person otherwise subject enough to tell strange Stories.

Some use, as is said above, a forked Rod, holding the two Ends in their Hands: Others tie a Hazle-Wand to another streight Stick, and holding it in their Hand, do so walk over the Hills and Places where they expect Metals. But they all own the Rod to be very cross-grained, and that it will *work*, as they call it, in some Mens Hands only, and at some certain Times, and not at others, in the Hands of the same Persons.

**VIRIDARIO eligenda**, is a Writ that lies for the Choice of a *Verderor* in the Forest.

**VIRILIA**, the Privy-Members of a Man including the *Penis* and *Testes*. L.

**VIRTUAL Focus**, or *Point of Divergence* in a Concave-Glass, is the Point *e* in the following Figure.



Let the Concavity of the Glass be *abc*, and its Axis *de*: Let *fg* be a Ray of Light falling on the Glass, parallel to the Axis *de*; and let *d* be the Centre of the Ark *abc*. This Ray *fg*, after it hath passed the Glass at its Emerfion at *g*, will not proceed directly to *h*, but be refracted from the Perpendicular *dg*, and will become the Ray *gk*. Draw then directly *gk*, so as that it may cross the Axis in *e*. The Point *e* so found, Mr. *Molyneux* calls the *Virtual Focus*, or *Point of Divergence*. P. 56. *Dioptr. Nov.*

**VIRTUE**; is a free elective and-acquired Habit of the Mind, whereby we are constantly inclined to do, and do in Fact act or not act, pursue or avoid, according to the Rules of true Prudence.

**VIS**, or *Force*; as *vi & armis*, by Force of Arms. And this *Vis* is fivefold, *Vis impulsiva ablativa*, *expulsiva*, *turbativa*, and *inquietativa*. *Vis ablativa*, is the taking away of moveable Things. And hence accrues an Action, *Quare vi & armis*, &c. *Vis compulsiva*, is when any one is cast out of his Possession by Force and Arms. *Vis turbativa*, is when any one is disturbed in his Possession, as when two strive to possess the same Thing. *Vis inquietativa*, is when one Man will not suffer another quietly to enjoy his Right, or to do any thing in his own Bounds or Limits. And from all these some sort of Action will arise.

**VIS Centrifuga**, is the Force by which any Body revolving round another, endeavours to fly off from the Axis of the Motion, in a Tangent to that Curve.

The Centrifugal Force is always proportional to the Periphery which any Body describes in its Motion round the Axis of its Motion, by the first Theorem of Mr. *Huygen's de vi Centrifuga*.

**VIS Centripeta**, is that by which any Body (from what Cause soever) tends towards any Point as to its Centre.

Of this kind is *Gravity*, by which Bodies tend toward the Centre of the Earth: And such is the *Magnetical Force* by which Iron tends towards the Centre of the Magnet: And of this kind is that Force or Power, whatever it be, by which all the Planets are continually drawn from a Rectilineal Motion, and forced to revolve in Curves.

The Quantity of this Centripetal Force is of three kinds; *Absoluta*, *Acceleratrix*, and *Motrix*.

The *Absolute Quantity* of it, is its Measure, greater or less, according to the Efficacy of the Cause that produces it; and which exerts itself on all Bodies in the Regions round about: As the *Magnetical Virtue* in some Magnets is greater than in others, tho' of the same Dimensions.

*Vis Centripetæ Quantitas Acceleratrix*, is its Measure proportionable to the Velocity which it produces in a given Time. Thus the Power of a Loadstone is greater at a less, and lesser at a greater Distance from the Stone. Gravity is greater in Valleys, and less on the Tops of high Mountains (as is plain from Experiments of Pendulums) and is yet less at remoter Distances from the Earth: But at equal Distances, 'tis always the same, because all Bodies, heavy or light, great or small, abstracting from the Resistance of the Medium, are equally accelerated in their Descent.

*Vis Centripetæ Quantitas Motrix*, is its Measure proportionable to the Motion which it generates in a given Time: As the Weight is greater in a greater Body, and less in a lesser; and in the same Body it is greater near the Earth, and less in remote Regions. This Force is the *Gravity* or Tendency towards the Centre of the whole Body, and is all one with its *Weight*, being alway discoverable by some equal and contrary Force hindering the Descent of the heavy Body.

The *Vires Centripetæ*, are always as the Squares of the Velocities divided by the Radii of the Circles described round the Centre.

And also reciprocally, as the Squares of the Periodical Revolutions divided by the Radii.

Wherefore if the Periodical Times be equal, both the Centripetal Forces and Velocities, will be as the Radii; & *vice versâ*.

If the Squares of the Times of the Periodical Revolutions are as the Radii, the Centripetal Forces are



are equal; and the Velocities in half the Ratio of the Radii; & *vice versâ*.

If the Squares of the Periodical Times are as the Squares of the Radii, the Centripetal Forces are reciprocally as the Radii, and the Velocities equal, and *vice versâ*.

If the Squares of the Times of the Periodical Revolutions are as the Cubes of the Radii, or *Distances from the Centre* (which is the Case of all these Planets moving round the Sun, and of the *Moon's* or *Secondary Planets* moving round the Primary) then the Centripetal Forces (or Gravity of Bodies) are as the Squares of the Radii or Distances from the Centre (as we find it to be) and Velocities are in half the Ratio of the Radii, and *vice versâ*: See Sir Isaac Newton's *Princip. Phil. Mathemat.* pag. 39.

If the Centripetal Force of any Body moving round another, be as the Distance; that Body moves in an Ellipsis, having its Centre in the Centre of that Force; or perhaps in a Circle equal to that Ellipsis. *Idem*.

As to which, *Gallilæus* hath this Theorem, that if such an Ellipsis, its Foci becoming infinitely distant, should change into a Parabola, the Body would move into the Curve of such a Parabola; and the *Vis Centripeta* respecting now a Centre infinitely distant, would grow *Equable*. To which Sir Isaac Newton adds, that if a Parabolick Section of a Cone, by the Inclination of its Plane to the Side of the Cone, should be turned into an Hyperbola, the Body would continue to move in its Perimeter; and its *Centripetal Force* would be changed into a *Centrifugal one*.

If any Body freely revolve round the Centre, as in the case of the Planets round the Sun, its Centripetal and Centrifugal Forces must be equal.

*VIS Impressa*, is an Impulse, Force, or Action, communicated to, and exercised upon any Body, in order to change its present State, either of Rest or Motion, uniformly forward in a right Line. *Newt. Princip. Mat.* This Force consists entirely in Action, and after that ceases, cannot remain in any Body: for the Body continues in its new State, whether of Motion or Rest, by the *Vis Inertiæ* only.

*VIS Insitæ Materiæ*, is the bare Power of Resistance only, by which every Body, as much as it may, endeavours to continue in that State in which it is, either of Rest, or Motion, uniformly forward in a right Line. This is always proportionable to the Body or Mass which it is in, and differs nothing from the *Inactivity* of the Matter or Body, but only in the Manner of Conceiving it: And therefore, this *Vis Insitæ*, may most properly be called *Vis Inertiæ*. *Newt. Princip. Math.*

*VIS Motrix*, is the Power which produces the Motion of any Body from Place to Place: Thus Gravity is a *Vis Motrix* downwards, or towards the Centre of the Earth.

*VIS INERTIÆ Materiæ*: This *Vis Inertiæ* is no where more conspicuous, than in the sudden Motion of a Vessel full of Liquor upon a horizontal Plane; at first the Liquor seems to move with a Direction contrary to that of the Vessel, not that there is any such Motion really impress'd upon the Liquor, but that the *Vis Inertiæ* endeavouring to continue it in its State of Rest, the Vessel cannot immediately communicate its Motion to the Liquor: But the Liquor perseveres in its State of Rest, whilst the Vessel moves forward, and so seems to move a contrary way. But when once the Liquor has the Motion of the Vessel communicated

to it, and begins to move with a Velocity equal to that of the Vessel; if the Vessel be suddenly stopped, the Liquor continues its Motion, and dashes over the Sides of the Vessel.

The Resistance of all fluid Mediums against Bodies moving thro' them, is chiefly owing to this *Vis Inertiæ*; as you will find under *Resistance*.

*VIS STIMULANS*; a Term used by Dr. *Chéyenne* in his Book of Fevers, and by some other Physicians; and they understand by it such a Quality in any Fluid, whereby the Particles of it are disposed to make a real Division, or a violent Inflexion of the nervous and membranous Fibres of the Body; which occasions frequent and forcible Reciprocations, Succussions, and Derivations of the *Liquidum Nervorum* into the Muscles and Contractile Fibres of the Canals of the Body, whereby all the involuntary Muscles are brought into violent Contractions, and the *Emissaries* of the Glands are squeezed. See *Bellini de Urinis & Pulsibus*, & *de Motu Cordis*.

*VISCERA*, are the Bowels contained in the three great Cavities of the Body, as the Anatomists call them: They are called also *Extæ* and *Interranea*.

*VISCOUNT*, *Viccomes*, *Viscount*, signifies as much as Sheriff; betwixt which two Words there is no other Difference, but that the one comes from the *Normans*, and the other from the *Saxons*. See *Sheriff*. With us now, a *Viscount* or *Vicount*, is a Person having the next Degree of Nobility below an Earl; and tho' it be an old Name of Office, 'tis a new one in Dignity, being not in use with us 'till the Time of *Hen. VI*. But 'tis of greater Antiquity in other Countries. See *Selden's Titles of Hon.* fol. 761.

*VISION*: The Physical Cause of Vision seems to be, that the Rays of Light striking on the Bottom of the Eye, do there excite certain Vibrations in the *Tunica Retina*; which Vibrations being propagated as far as the Brain, by the *solid Fibres of the Optick Nerves*, do there cause the Sense of *Seeing*. For as *Dense* Bodies do retain their Heat longest, and that in proportion to their Density, they retain it longer, as they are more dense; so the Vibrations of their Particles are of a more durable Nature than those of rarer Bodies, and therefore can be propagated to greater Distances: Wherefore the solid and dense Fibres of the Nerves, whose Matter is of an homogeneous and uniform Nature, are very proper to transmit to the Brain such Motions as are impress'd on the external Organs of all our Senses. For that Motion which can preserve it self a good while, in one and the same Part of any Body, can also be propagated a great way from one Part of it to another; provided the Body be of an homogeneous Nature, and that the Motion be not reflected, refracted, interrupted, or disturbed by any Inequality in that Body.

Rays of Light therefore of divers kinds, will excite Vibrations in the *Retina* of different *Magnitudes*; and these Vibrations, according to such their different Magnitudes, will produce the Sensations of different kinds of Colours; just almost as in the Air, Vibrations of different Magnitudes produce the Sensation of different sounds. *v. gr.* (as you will find under *Colour*) such Rays of Light as are most refrangible, excite the most short Vibrations, and cause the Sensation of a deep Violet Colour: While such Rays as are least refrangible, do excite the *longest* Vibrations; and cause the Sensation of a deep red Colour. And Rays



of Light of all intermediate kinds, do excite accordingly intermediate Vibrations, and so cause the Sensations of the other intermediate Colours, between the two Extremes of Violet and Red.

VISIBLE *Horizon* : See *Horizon*.

VISIBLE *Place* of a Star : See *Apparent Place*.

VISIBLE *Species* : See *Speciales Visibiles*.

VISION, is a Sensation in the Brain, proceeding from a due and various Motion of the Optick Nerve, produced in the Bottom of the Eye, by the Rays of Light coming from any Object ; by which means the Soul perceives the illuminated Thing, together with its Quantity, Quality, and Modification.

Whether the Picture of the Object be made on the *Tunica Retina*, or on the *Choroides*, there is a great Dispute between Mr. *Pecquet* and Mr. *Mariotte*, in the *Philos. Transf.* N<sup>o</sup> 59, &c.

As to the Manner how this noble Sense of Seeing is produced, there were many Hypotheses among the Ancients.

1. The *Stoicks* imagin'd, That certain visual Rays went from the Brain through the Optick Nerve and Eye, and from thence to the Object ; and there (just like a Blind Man's Staff) feel out the Figure, Colour, and Dimensions of the Object.

2. The *Pythagoreans* thought, That there went some visual Species out of the Eye to the Object, which were immediately reflected back again from thence to the Eye, and so produced *Vision*.

3. *Plato* supposed, That both from the Eye and the Object there came substantial Effluvia, which meeting half way, and encountering the Ocular Effluvia, the latter were beat back again to the Eye, and there communicated the Impression they had received from those Effluvia which came from the Object ; and so caused the Sense of Seeing.

4. *Aristotle* asserted, That the Colours of all Objects did move the transparent Medium, as that did the Eye, and thereby communicate their Images to the Brain, or *commune Sensorium*.

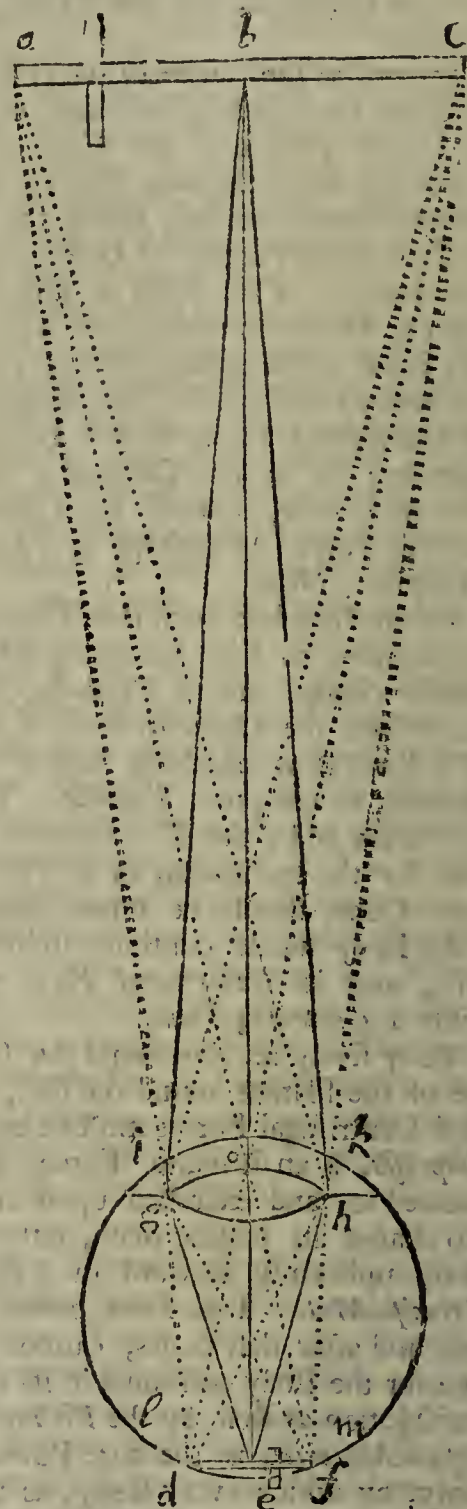
5. *Epicurus*, judiciously, rejecting the Notion of an Emanation of visible Species from the Eye, and not thinking the Action of the intermediate Air or Medium sufficient to account for Vision, rightly concluded, That the Sense of Vision was produced by a substantial material Efflux from the Object to the Eye.

6. *Cartez* supposes Vision performed by bare Motion only, without any material Emanation from the Object ; but only that the Light (which with him also is not a Body, but the Motion of the finer Parts of the *Medium*) moves the Eye, just after the same manner as the Object is supposed to have determin'd it ; which Motion is continued along the Optick Nerve up into the Brain, where it moves the *Conarion*, or *Glandula Pinealis*, with him the Seat of the Soul ; and, by that means, produces internal Sensation, and enables the Soul to judge accordingly.

The Manner of the Vision with the naked Eye, according to Mr. *Molyneux* his Explication of it, in *Dioptr.* Nov. p. 103.

Suppose *abc* an Object, *iklem* the Globe of the Eye, furnished with all its Coats and Humours ;

but here the Chrystalline Humour *gob* is only express'd, as being principally concern'd in forming the Image on the Fund of the Eye.



1. From each Point of the Object we may conceive Rays flowing to the Pupil of the Eye *ik* ; as here from the middle Point *b*, there proceed the Rays *bg*, *bo*, *bb* ; these, by means of the Coats and Humours of the Eye, and especially by the Crystalline Humour *gh*, are refracted and brought together on the *Retina* or Fund of the Eye in the Point *e*, and there the Point *b* is represented. For we may conceive the Chrystalline Humour *gh*, as it were a Convex-glass, in the Hole of a dark Chamber *iklmk*, and that *def* is the distinct Base of this Glass.

What is here said of the Point *b*, and its Representation at *e*, may be understood of all the other Points in the Objects, as of *a* and *c*, and their Representations at *f* and *d*. For, according to Sir *Isaac Newton*'s best Hypothesis of Light, each Ray has its innate Colour, and so will represent it where it falls.

2. As in a dark Chamber that has a Hole furnished with a Convex-glass, if the Paper that is to receive the Image in the distinct Base, be either nigher to, or farther from the Glass, than its due Distance,



Distance, the Representation thereon is confus'd : For then the Radius-Pencils do not exactly determine with their Apices on the Paper ; but those from one Point are mix'd and confus'd with those from the adjacent Point : So in the Case of *Plain Vision*, 'tis requisite that the Pencils should exactly determine their Apices at *d e f* on the *Retina*, or else Vision is not distinct.

Therefore Nature has so contriv'd the Eye, that it should have a Power of adapting it self in some measure to nigh and distant Objects, for they require a different Conformation of the Eye, because the Rays proceeding from the Luminous Points of nigh Objects do more diverge than those from more remote Objects : But whether this Variety of Conformation consists in the Crystallines approaching nigher to, or removing farther from the *Retina* ; or in the Crystallines assuming a different Convexity, sometimes greater, sometimes less, according as is requisite, is left to the Scrutiny of others ; and particularly the Curious Anatomists. This only may be said, That either of these Methods will serve to explain the various *Phænomena* of the Eye : And that both these may attend each other, *viz.* a less Convex-Crystalline requires an Elongation of the Eye, and a more Convex-Crystalline requires a shortning thereof ; as a more flat Convex Object-glass, or of a larger Sphere, requires a longer Tube ; and one protuberant, bulging, or of a smaller Sphere, requires a shorter Tube.

3. By the former Figure we perceive the Rays from each Point of the Object are all confus'd together on the Pupil in *g h*, so that the Eye is placed in the Point of the greatest Confusion : But by means of the Humours and Coats thereof, each Cone of Rays is separated, and brought by it self to determine in its proper Point on the *Retina*, there painting distinctly the vivid Representation of the Object, which Representation is there perceived by the *Sensitive Soul*.

4. We are likewise to observe, That the Representation of the Object *a b c*, on the Fund of the Eye *f e d* is inverted : For so likewise it is on the Paper in a dark Room ; there being no other Way for the Radius Cones to enter the Eye, or the dark Chamber, but by their Axis *a o*, *b o*, *c o*, crossing in the Pole *o* of the Crystalline, or Glass.

But how comes it to pass, that the Eye receiving the Representation of a part of an Object on that Part of its Fund which is lowermost, or nighest the Centre of the Earth, perceives that Part of the Object as uppermost, or farthest from the Centre of the Earth ? In Answer to this, let us imagine, that the Eye, in the Point *f*, receives an Impulse or Stroke by the Protrusion forwards of the Luminous Axis *a o f*, from the Point of the Object *a* ; must not the visive Faculty be necessarily directed hereby to consider the Stroke, as coming from the Top *a*, rather than from the Bottom *c*, and consequently should be directed to conclude the Representation of the Top ?

Therefore we may be satisfied by supposing a Man standing on his Head : For here, tho' the

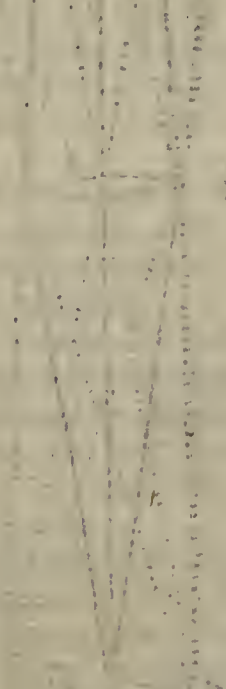
upper Parts of Objects are painted on the upper Parts of the Eye, yet the Objects are judg'd to be erect. And from this Posture of a Man, the Reason appears, why we have us'd the Words *farthest from*, and *nighest to the Centre of the Earth*, rather than *upper* and *lower* : For, in this Posture, because the upper Parts of the Objects are painted on that Part of the Eye nighest the Earth (tho' really the upper Part of the Eye) they are judg'd to be farthest removed from the Earth.

What is said of *Erect* and *Reverse*, may be understood of *Sinister* and *Dexter*.

5. The Image of an *Erect Object* being represented on the Fund of the Eye *Inverted*, and yet the Sensitive Faculty judging the Object *Erect*, it follows, That when the Image of an *Erect Object* is painted on the Fund of the Eye *Erect*, the Sense judges that Object to be *Inverted*.

6. The Magnitude of an Object is estimated by the Angle the Object subtends before the Eye. Thus, the Length of the Object *a c* is estimated by the Angle *a o c*, *f o d*, and this is called the *Optick Angle*.

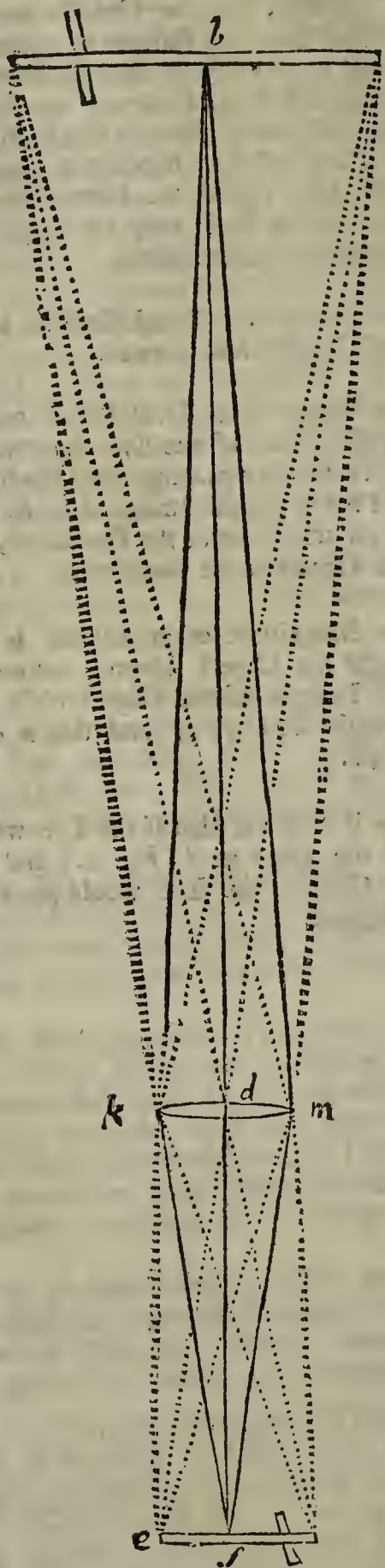
Whence it follows, that if the Eye were placed instead of the Glass at *d* (Fig. 2.) and *a b c*, or *e f g* were Objects, the Eye would perceive them of equal Bigness.



The former Figure shows a Man standing on his Head, and the Rays from each Point of the Object are all confus'd together on the Pupil in *g h*, so that the Eye is placed in the Point of the greatest Confusion : But by means of the Humours and Coats thereof, each Cone of Rays is separated, and brought by it self to determine in its proper Point on the *Retina*, there painting distinctly the vivid Representation of the Object, which Representation is there perceived by the *Sensitive Soul*.

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The Point  $o$ , which is the Vertex of the Optick Angle, is variously assigned by various Authors; some placing it in the Centre of the Eye; others in the Vertex of the Crystalline; others in the Vertex of the outward Coat or Cerena of the Eye; but 'tis a Matter of no great Consequence where-ever we place it; for according to the Bigness of this Angle  $a o c$ , the Image on the Fund of the Eye is bigger or less.

7. We perceive the Rays that flow from the Point  $b$ , do proceed to the Eye *Diverging*, as  $bg, bo, bh$ . And if the Object  $a c$  were infinitely distant from the Eye, or so distant from the Eye, that the Breadth of the Pupil  $ik$  were insensible in Comparison to this Distance; then the Rays  $bg, bo, bh$ , would proceed as it were parallel, and so fall on the Eye: In both which Cases, by means of the

Refractions of the Eye, they are brought together, and point the Image of the Point  $b$ , on the Fund of the Eye at  $e$ .

But if the diverging Rays  $bu, bx$  (Fig. 1.) that flow from the Point  $b$ , meet the Convex-glass  $vx$ , and are thereby made to converge, as  $vi, xk$ , and so fall on the Eye; and there passing through the Crystalline  $gh$ , are made to converge yet more, as  $ie, ke$ : Here they cross in the Point  $e$ , before they reach the Retina  $rt$ , and consequently do point thereon the Image of the Point  $b$  confusedly, for 'tis planted on the Space  $rt$ ; whereas to cause distinct Vision, it should only be painted on a correspondent Point on the Retina.

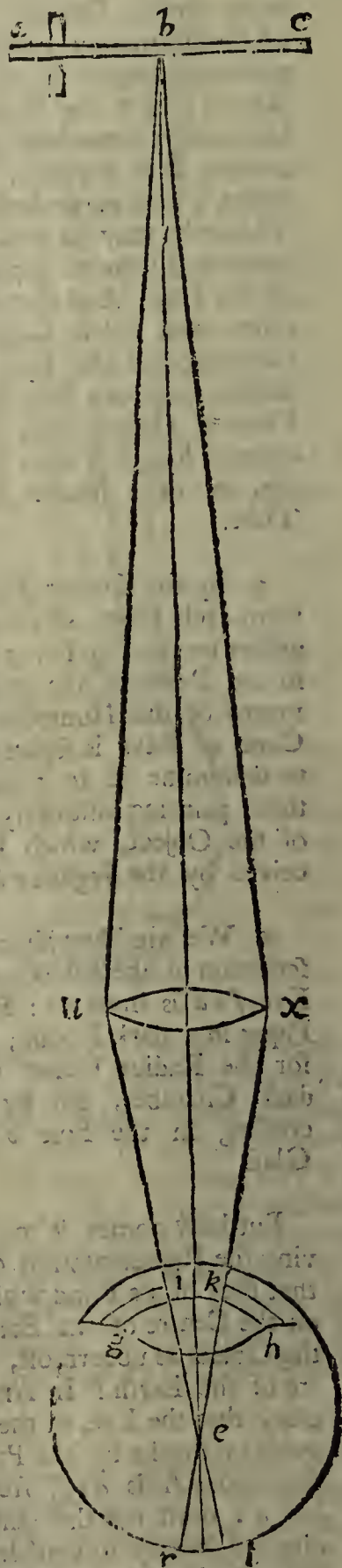
And this is the Fault of their Eyes, who are called *Myopes*, *Purblind*, or *Short-sighted*: For in them the Crystalline is too Convex (as in Fig. 3. both the Convex-glass and Crystalline joined together, make too great a Convexity) uniting the Rays before they arrive at the Retina. And therefore they are helped by *Concave-glasses*, which take off from the too great Convexity of their Crystalline, some part of its Refractive Power: Or rather these Concaves make the Rays diverge so, that their Crystalline shall be sufficient only to bring them again together, so that they be not touched 'till they arrive at the Fund of the Eye.

*Myopes* are also helped, by holding the Object very near; for then the Rays that fall on their Eye from any single Point, do more diverge, than when the Eye is farther from the Point, and consequently their too Convex Crystalline doth but suffice to bring them together, on the Retina.

8. On the contrary, the Eyes of Old Men have their Crystalline too flat (as Fig. 4.) and cannot correct the Divergence of the Rays

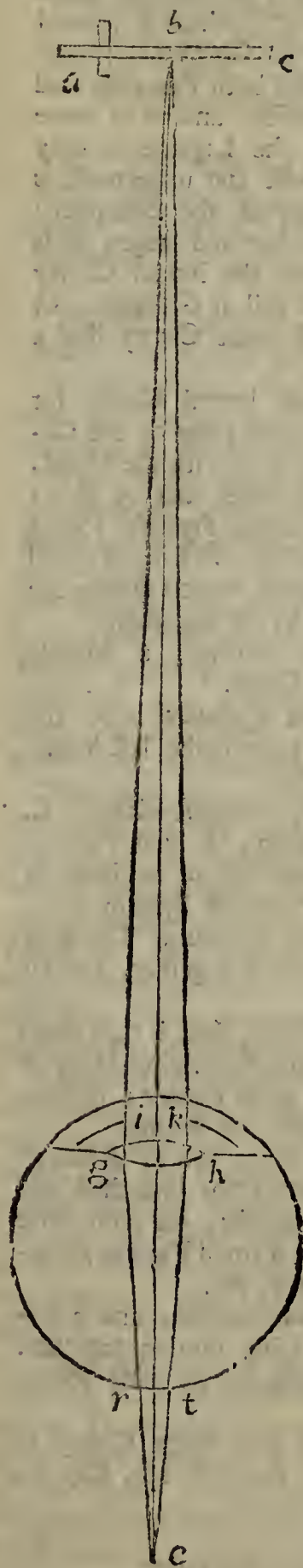
$bu, bk$ , to make them between the Retina  $rt$ , but beyond the Eye at  $e$ . Wherefore for their help 'tis requisite they add the adventitious Convexity of a Glass; that both it and the Crystalline together, may be sufficient to unite the Rays just at the Retina: And from hence it appears, that Spectacles help

Old





Old Men, not by magnifying an Object, but by making its Appearance distinct; for Old Men cannot read the largest Print without Spectacles, and yet with Spectacles they read the smallest; tho' these with Spectacles do not appear so large, as those without Spectacles.



9. What is said of the confused or distinct Representation of a Point in the Object, may be understood of the confused or distinct Representation of the whole Object; at least, for those Parts that lie pretty nigh adjacent to that Point that is looked at. For here we do not see a Point in the strict Sense of the Mathematicians, but in a Physical Sense, for the smallest Part imaginable; and the whole Object consisting of such Points, what is shewn of one Point, may be understood of every Point in the Object.

*Distinct Vision* is caused, when the Pencils of Rays from each Point of an Object do accurately determine in correspondent Points of the Image on the *Retina*.

*Confused Vision*, is caused when these Pencils do intermix one with another.

*Clear Vision*, is caused by a great Quantity of Rays in the same Pencil illuminating the correspondent Points of the Image strongly and vigorously.

*Faint Vision*, is when a few Rays make up one Pencil: And tho' this may be *distinct*, yet 'tis *dark* and *obscure*; at least, not so *bright* and *strong*, as if more Rays concurred.

**VISION**, in *Opticks*, is that which is performed by means of Rays refracted or turned out of their way by passing through Mediums of different density, principally through Glasses and Lenses.

**VISITATION**, is that Office or Action that is performed by a Bishop in every Diocese once every three Years, or by the Arch-deacon once a Year, by visiting the Churches and their Rectors, &c.

**VISNE**: See *Venue*.

**VISORIUS**: See *Optick Nerves*.

**VISU Franci plegii**, is a Writ to exempt him from coming to the *View of the Frank-Pledge*, who is not Resident within the Hundred; for Men are

bound to this *View*, by reason of their Habitation, and not of Lands held where they dwell not.

**VISUAL-ANGLE**, is the same with *Optick-Angle*; which you will find under *Optick Pyramid* and *Optick Triangle*.

**VISUAL Point** in *Perspective*, is a Point in the horizontal Line, wherein all the Ocular Rays unite; as if a Man stood in a long streight Gallery, wherein looking directly forward, the Sides, Floor, and Ceiling at last seem to be united, and touch one another in a Point or Common Centre.

**VISUAL Rays**: See *Rays*.

**VITAL**, in *Anatomy*, that which ministers principally to the constituting or maintaining of Life in the Bodies of Animals, as the *Vital Parts* are reckoned the *Heart*, *Lungs* and *Brain*.

**VITAL Faculty**, is an Action whereby a Man lives, which is performed, whether we design it or no; such are the Motions of the Heart, Respiration, Nutrition, &c. It depends chiefly upon the *Cerebellum*. It is the same with Natural Faculty, tho' the Ancients distinguished them, placing the Natural in the Liver, and the Vital in the Heart.

**VITAL Flame**: See *Flamma Vitalis*.

**VITAL Functions**, are those Actions of the *Vital Parts* whereby Life is effected, so that it cannot subsist without them, as the musculous Actions of the Heart, the respiratory Action of the Lungs, the secretory Action of the *Cerebellum*, the Circulation of the Blood and Spirits thro' the Arteries, Veins and Nerves.

**VITAL Indication**, in the Art of Medicine, is such an one as requires the restoring and preserving of the natural Strength of the Body.

**VITALIGO**, a sort of Leprosy; there are three kinds of them.

*Albus*, where the Colour is White, something rough, and not continued, like so many Drops here and there; but sometimes it spreads broader, and with some Intermissions.

*Melas* differs in Colour, because it is Black, and like a Shade; in the rest they agree.

*Leuce* has something like *Albus*; but it is whiter, and descends deeper, and in it the Hairs are White, and like Down: All these spread, but in some quicker, in others slower.

**VITRIFICATION**, the turning of any Body into Glass by the Force of Fire: This (by the Chymists) is look'd upon as the Ultimate Action of Fire; and Bodies when once they have gain'd the Form of a Glass, do (generally speaking) continue in that Form, and are not capable of putting on any other Shape.

Most kinds of *Vitrifications* (as also *Calcinations*) are made by Salts uniting and incorporating with the Metalline Particles.

**VITRIOL of Copper or Venus**, is *Blue Chrystals* made by a Solution of Copper in Spirit of Nitre, Evaporation and Chrystallization in a cool Place. These are used as Causticks, but they will dissolve if expos'd to the Air.

There are other Chrystals of *Venus* made by distilled Vinegar, and they are what is called *Verdigrease*; which see.

**VITRIOL or Copperas**, is made at *Bricklesey* in *Essex*, according to Mr. Ray's Account thus: They lay the Copperas Stones (which *Wormius* in his *Mus. c. 13. Sect. 2.* saith, are chiefly found in the Isle of *Shepey*; but are indeed gather'd upon the Coasts of *Kent* and *Sussex* in many Places) on a



large Bed or Floor prepared in the open Air, underneath which there are Gutters or Troughs, disposed to receive and carry away the Liquor impregnated with the Mineral to a Cistern, where it is reserved. For the Air and Weather dissolving the Stones, the falling Rain carries away along with it the Vitriolick Juice or Salt which is dissolved thereby. This Liquor they boil in large Leaden-Pans, putting in a good Quantity of old Iron: When it is sufficiently evaporated, they pour it out into large Troughs wherein it cools; and the Vitriol chrySTALLIZES to the Sides, and to Cross-Bars of Wood, which are placed in the Troughs. The Liquor remaining after this ChrySTALLIZATION, they call the *Mother*, which is reserved to be boiled and evaporated again.

*Wormius* saith, the Liquor is six or seven Days boiling to a due Consistence; and that it can be boiled in nothing but a Leaden Vessel.

*Matthiolus* describes the Way of making Vitriol in *Italy*, to be something different from ours; for, he saith, they burn the Copperas-Stones in small Heaps, till the greatest Part is reduced to a Calx or Ashes, which being powdered, is mingled and agitated with Water, in large Vessels, to get out the Vitriolick Matter; then they draw off the clear Water after the grosser Matter hath subsided, and boil it to a due Consistence, throwing in Pieces of old Iron or Brass (according to the Design of the Operator) and then put it to chrySTALLIZE in wooden Vessels.

VITRIOL of *Mars*, or *Salt of Steel*, is made by dissolving Steel in some proper *Acid Menstruum*, then evaporating and chrySTALLIZING to gain the above as in Copper.

VITRIOL of *Silver*, or of the *Moon*: See *Chrystals of Silver*.

VITRIOLATE *Tartar*: See *Tartar Vitriolate*.

VITRIOLATED, in *Chymistry*, turned into Vitriol, or having Vitriol infused in it.

VITRIOLICK, having the Quality or partaking of the Nature of Vitriol.

VITRIOUS *Humour*, or *Glassy Humour of the Eye*, is the third Humour of the Eye, so called from its Resemblance of the melted Glass. 'Tis thicker than the *Aqueous*, but not so solid as the *ChrySTALLINE*. 'Tis round or convex behind, and somewhat plain before, only hollowed a little in the Middle where it receives the *ChrySTALLINE*. It exceeds both the other Humours in Quantity.

VITRIOUS *Tunicle*, a thin Film or Coat, which is said to separate the *Glassy Humour* from the *ChrySTALLINE*; tho' there are some who absolutely deny, That there is any such Coat in the Eye, before the Humours are taken out and exposed to the Air.

VITTA, in *Anatomy*, that Part of the *Amnion* that sticks to the Head of an Infant when it is just born.

VIVA VOCE: See *Dépositions*.

VIVIPAROUS *Animals*, are such as bring forth their Young living and perfect; by which they are distinguished from *Oviparous* ones, which lay Eggs, which after that are hatched in living Creatures.

VIVIFICATION, with *Physicians*, the Art of Vivifying, that is, of contributing to the Action that gives or maintains Life, *L*.

ULCER, *Ulcus*, *L*: a Solution or Discontinuity of Texture, or a Loss of Substance in the fleshy

Parts of the Body proceeding from an internal Cause.

ULCERATION, a little Aperture or Hole in the Skin, occasioned by an Ulcer.

ULLAGE of a *Cask*, in *Gauging*, is so much as a Vessel wants of being full.

ULNA, or *Focile Majus*, is the greater Bone betwixt the Arm and the Wrist, which is jointed upward with the Shoulder by the *Ginglymus* (which see); and therefore it has there both Processes and Cavities; two oblong Processes, and as it were triangular and rugged, that the Ligaments may knit it strongly. The foremost and uppermost is less, and goes into the Cavity of the Shoulder: The backward Process is thicker and larger, ends in an obtuse Angle, and enters the hinder Cavity of the Shoulder; the *Latins* call it *Gibberus*: In the middle of these there's a great Cavity like a Semicircle.

It has yet another external lateral Cavity for the Head of the *Radius*, or lesser Bone of the *Cubitus*; it is jointed at the lower End with the Wrist, both by a Cartilage in the Middle, and by an acute Process, and therefore called *Styloides* (being like a sharp-pointed Pen used in *Writing-Tables*) whence there arises a Ligament, which fastens the *Cubitus* and the Joint of the Wrist together.

ULNARIS *Extensor*, in *Anatomy*, a Muscle that is also called *Extensor Carpi*.

ULTIMA BASIA, with *Painters*, *i. e.* the last Kisses, a Phrase used to express the last finishing Touches with the Pencil.

ULTRA MUNDANE, *Ultramundanus*, *L*. *i. e.* that is, beyond the World; is that Part of the Universe which is supposed to be without or beyond the Limits of our World or System.

UMBELLÆ, in *Botany*, the round Tufts or Heads of certain Plants, set thick together, and all of the same Height, *L*.

UMBELICUS, in an *Ellipsis*, &c. is that *Focus* about which the Motion of any Revolving Body is made, and which it respects as its Centre: So that either *Focus* may be called by this Name.

UMBELLIFEROUS *Plants*, are by *Botanists* accounted such as have their Tops branched and spread out like a Lady's Umbrella; on each little Sub-division of which there is a small Flower growing; as *Fennel*, *Dill*, *Parsley*, &c.

This Flower is always *Pentapetalous*, and is succeeded by two naked Seeds lying joining together, which are the true Distinctions of these *Plants* from others.

The *Umbelliferous* are a very large Genus of *Plants*, and by our *Accurate Botanist*, Mr. Ray, are thus distinguished.

*Umbelliferous Plants*, are either,

I. Such as have a compounded Leaf, of a Triangular and *Pinnate* Form: And the Seeds of these are either,

1. Broad, flat, and plain, like Leaves almost; at the *Sphondylium*, *Pastinaca Latifolia*, *Panax Heracleum Tordylium*, *Orcoselinum*, *Thyselinum*, *Apium Cicuta foliis*, *Daucus Alsaticus Carvisfolia*, *Anethum*, *Pucedanum*, *Thapsia*, *Ferula*, &c.

2. With



2. With a Seed more tumid, and less compressed and flat than the former : As the *Cachrys*, *Laserpitium*, *Cicutaria vulgaris*, *Scandix*, *Cerrefolium*, *Myrrhis Sativa*, *Angelica*, *Levisticum*, *Siler Montanum*, *Bulbocastanum*, *Sisarum*, *Oenanthe*, *Sium*, *Pimpinella Apium*, *Cicuta*, *Vifnaga*, *Saxifraga*, *Crithmum*, *Fœniculum*, *Daucus vulgaris*, *Anisum*, *Caucalci*, *Coriandrum*, *Pastinaca Marina*, &c.

II. Such as have a simple or an undivided Leaf, or at least one, only a little jagged : As the *Pentefoliata*, *Buplerum*, *Astrantia Nigra*, *Sanicula*, and the *Seseli Æthiopicum*.

UMBILICAL Region, is that Part of the *Abdomen* lying round about the Navel.

UMBILICAL Vessels, are the *Veins*, *Arteries*, &c. that belong to the Navel, or rather are enwrapped in the *Navel-string*.

The *Navel-string* is membranous, wreathed, and unequal, arising out of the Middle of the *Abdomen* (viz. the *Navel*) and reaching to the *Placenta Uterina* : 'Tis usually half an Ell in Length; and as thick as one's Finger. It was convenient to be so long and lax, that when the *Fœtus* in the Womb grows strong, it might not break it by its sprawling and tumbling about; and after it is born, the *Secundine*, or *After-birth*, might be drawn out the better by it.

The Way that it passes from the Navel to the *Placenta*, is very unconstant; for sometimes it goes upon the Right-hand to the Neck; which having encompassed, it descends to the *Placenta*, and sometimes it goes on the Left-hand up to the Neck, &c. Sometimes it comes not to the Neck at all, but goes first a little up towards its Breast, and then turns round its Back, and from thence passes to the *Placenta*.

The Vessels contain'd in this *String* (and which are enwrapped to a common Coat, called *Funiculus*, or *Intestinulum*) are four, one *Vein*, two *Arteries*, and the *Urachus*. For as for the Nerves which *Verheyen* suspects to be contained in it, or the *Lacteal Vessels* which *Bidloo* thinks he has observed, I shall not reckon them among these Vessels, because these Authors speak but faintly of them.

The *Vein* is larger than the *Arteries*, and arises from the Liver of the *Fœtus* (viz. out of its Fissure) by the Trunk of the *Vena Portæ* (of which it seems to be but a Branch) and from thence passing out of the Navel, it runs along the *Funiculus* to the *Placenta*, into which it is implanted by innumerable Roots; but in its Passage it sends some little Twigs into the *Arteries*.

The *Ancients*, that thought the *Fœtus* was nourished by the *Mother's Blood* only, taught the sole Use of this *Vein* to be, to carry Blood from the *Placenta* to it : And since it has been found out, and believed that it is nourished also (if not only) by *Chyle*, or *Succus Nutritius*, some have continued the same Office to this *Vein*, and think that the *Chyle* is brought by *Lacteal Vessels* arising out of the *Placenta*, as (they say) it was brought thither by the *Mother's Lacteals*. And indeed if any certain Discovery had been made of these same *Lacteæ*, we should have embraced this Opinion as the most probable. But we are not to form *Hypotheses* out of *Rational Notions* only, but much rather from what appears to the Eyes of the Dissector.

We do affirm therefore, That the *Umbilical Vein* serves for conveying to the *Fœtus* the Nutritious Juice separated in the *Placenta* from the *Mother's Arteries*. How this Separation is made, and how it is first of all turned into Blood, we shall consider by and by.

But together with this Juice there returns so much of the Arterial Blood (that comes from the *Fœtus*) as is not spent upon the Nourishment of the *Placenta*, or of the *Chorion* and *Amnios* : Which Liquors thus mixed, though by the *Umbilical Vein*, they are poured into the *Sinus* of the *Porta*, yet are they not distributed through the Liver by the usual Channels thereof only, but by the Venal Duct, is the greatest Part thereof conveyed in a direct Course and full Stream into the *Cava*, about the Liver.

Besides this *Vein*, which is common to all Creatures, there have been observ'd in Whelps and *Cornies* (and may perhaps in others) two small *Veins* more, that arising from the fourth involving Membrane peculiar to them, pass directly from the *Umbilicus* to the *Mesentery* of the *Fœtus*; as the other great one does to its Liver; which may strengthen the Opinion, That the *Chyle*, or *Succus Nutritius* is brought to the *Fœtus* by the *Umbilical Vein* (or *Veins*.) These *Veins* Dr. *Needham* calls *Omphalo-Mesentericæ*.

In the *Funiculus* are included also two *Arteries*, which are not both of them together so big as the *Vein* : They spring out of the inner Iliacal Branches of the great Artery : (Dr. *Needham* judges them to be derived immediately from the Extremity of the *Aorta*, before its Division) and passing by the Sides of the Bladder, they rise up to the Navel, out of which they are conducted to the *Placenta*, in the same common Cover with the *Vein* and *Urachus*, with which they are twined and wreathed not unlike a Rope. I say, they are inserted into the *Placenta*, and with the *Vein* make a most admirable Net-like Texture. But there is one Branch of each of them which is manifestly inserted into the *Amnios*. Dr. *Harvey* says, The *Vein* is conspicuous a pretty while before these *Arteries* appear.

In the Creatures mention'd in the foregoing Paragraph, there are besides these *Arteries*, others answering to, and accompanying the *Veins*, called *Omphalo-Mesentericæ*, abovementioned.

Blood and Vital Spirit are not carried by them from the Mother to the *Fœtus*, as many from *Galen* have taught; but, on the contrary, Spirituous Blood is driven from the *Fœtus*, by the beating of its Heart, to the *Placenta* and the Membranes for their Refection and Nourishment; from which what Blood remains, circulates back again in the *Umbilical Vein*, together with the *Succus Nutritius* afresh imbibed by its Capillaries dispersed in the *Placenta*. But besides Arterial Blood, there flows out of the Navel by them, Part of the *Succus Nutritius*, that was imported by the *Umbilical Vein*; namely, That of it which is more crass and cerene, which by one Circulation through the Heart (or it may be many) could not be changed into Blood : This Part, I say, flows out by these *Arteries*, which by their Branches that are dispersed through the *Amnios*, disimboque it by their little Mouths into it : For what Use shall be declared presently.

But besides these Uses which are commonly ascribed to these *Umbilical Veins* and *Arteries* by Anatomists,



Anatomists, *Verheyen* (with some Probability) assigns another.

Says he, "It is worth Inquiry, for what Purpose the Blood of the *Fœtus* is sent in such great Quantity out of its Body into the *Placenta*: Seeing, without doubt, a far less Quantity of Blood would suffice for its Nourishment: For no Part in the whole Body, if you except the Lungs and Liver, has such Abundance of Blood-Vessels as the *Placenta*. This must needs be for a certain common Use, which we judge to be a-kin to the Use of the Lungs, in those who being born, enjoy a freer Air: Namely, That as these do by the Help of the Lungs plentifully draw in from the Air a certain Matter highly necessary for the feeding the Vital Flame; so in the *Fœtus*, where the Lungs lie idle, such like Matter being received into the Mother's Blood by her Respiration, is separated therefrom by Help of the *Placenta*, and mixt with the Blood of the *Fœtus* (in the Umbilical Vein;) and as in the Lungs of Breathing Persons, some Heterogenous Matter is continually separated from the Blood; so in the *Placenta* certain Recrements of the Blood are deposited out of the Umbilical Arteries into the Veins of the Mother."

And here I shall transcribe a *Material Objection*, with the Answer to it, out of *Diemerbroeck*.

#### Objection.

*How can these Vessels (Veins and Arteries) when they have grown from the Belly of the Fœtus, to that Length as to reach the Membranes, penetrate and pass through them to the Placenta?*

#### Answer.

This is done in the same manner as the Roots of Herbs, Shrubs and Trees penetrate into the hard Ground, yea, often into thick Plants, Walls and Stones (which Water cannot enter) and root themselves firmly in them. For just so the first sharp-pointed and most fine Ends of the Umbilical Vessels, insinuate themselves by little and little and the Pores of the Membranes (for the Figuration of those Pores are fitted for their Entrance) and pass through them, and yet the Liquors contained in these Membranes cannot flow out by them: And when those Vessels inhering in the Pores, grow more out into Length, by little and little, the said Pores are more and more widened, (according to the Encrease of the Vessels) and are inseparably united unto, and grow in them.

The fourth Umbilical Vessel, is the *Urachus*, or *Urinary Vessel*. This is a small, membranous, round Pipe, endowed with a very straight Cavity arising from the Bottom of the Bladder up to the Navel, out of which it passes along within the common Cover, and opens into the *Allantoides*.

It is more apparently pervious in many of the larger Brutes, than it is in Man; in whom some have denied it any Cavity; but that it is hollow in him, is confirmed by many Histories of Persons adult, who having the ordinary Urinary Passage along the *Penis* stopt, the Passage in this Vessel has been unlocked, and they have made Water by the Navel, which could not have been imagined to have happened, if it had been originally a Ligament without any *Meatus*.

*Bartholin* and others have affirmed, that the *Urachus* in Men reaches no further than the Navel: How then comes that Humour into the *Allantoides*, that has perfectly the same Taste with the Urine in the Bladder? But their Error sprung from hence, that they thought a Human *Fœtus* had no *Allantoides*, and that Humour that is found in it, they thought had been contained in the *Chorion*. But this is in short refuted above, but more fully and accurately by Dr. *Needham*, *Lib. de formatio Fœtu*, cap. 3.

As to the Perviousness of the *Urachus*, I shall add this further, that in Abortions of five or six Months old, the Bladder of the *Embryo* is always full of Urine, out of which, if in the following Months it should not be emptied by the *Urachus*, the Bladder would soon burst, seeing there is daily some *Serum* separated from the Blood in the Kidnies, and sent to the Bladder; and the more the *Fœtus* increases, the more must need be separated. Yea, Dr. *Needham* affirms, that one may either press the Liquor contained in the *Allantoides* by the *Urachus* into the Bladder, and with a Pipe blow Wind out of the Bladder by the same way into the *Allantoides*.

Its Use has been sufficiently declared in the preceding Paragraph; as also above, when we delivered the Use of the *Allantoides*, which we shall not repeat.

These four Vessels (as has been said above) have one common Cover, which also keeps each of them from touching the other: It is called *Intestinulum* and *Funiculus* (by which it with its Vessels is sometimes understood.) It is membranous, round and hollow, indifferent thick, consisting of a double Coat (the inner from the *Peritonæum*, and the outer from the *Panniculus carnosus*.) Sometimes it self only is wreathed about like a Rope, the Vessels included in it running streight along its Cavity; and sometimes they are wreathed together with it.

In hath several Knots upon it here and there, which Dr. *Wharton* thinks to be *Papillæ*, or little Glands through which the Lacteal (or Nutritious Juice) distils out of the Cavity of the *Funiculus*, into the Cavity of the *Amnios*.

I cannot tell whether this be so, or no; but the Use that doting Midwives make of them, to guess by their Number how many Children more the Mother shall have, and by their Colour, whether those Children shall be Male or Female, is more ridiculous than superstitious.

UMBILICK Points, in *Mathematicks*, are the same with *Fœtus's*; which see.

UMBILICUS, the Navel, is a Part in the Centre of the *Abdomen*, to which the Navel-string in a *Fœtus* is joined, which is cut off after the Delivery.

UNCIÆ, in *Algebra*, signifies those Numbers which are prefixed before the Letters of the Members of any Power produced from a *Binomial*, *Residual*, or *Multinomial Root*.

Thus in the fourth Power of  $a + b$ ; that is,  $aaaa + 4aaab + 6aabb + 4abbb + bbbb$ , the *Unciæ* are 4, 6, 4.

The wonderful Sir *Isaac Newton* gives this Theorem for finding the *Unciæ* of any Power arising from a *Binomial Root*.

Let



Let the Index of that Power be called  $m$ ; then will the *Unciæ* arise from such a continual Multiplication as this, *viz.*

$$\begin{array}{ccccccccc} m-0 & m-1 & m-2 & m-3 & m-4 \\ 1 \times & \times & \times & \times & \times & \times & \times & \times & \times \\ 1 & 2 & 3 & 4 & 5 & & & & \end{array}, \text{ \&c.}$$

Thus if the *Unciæ* of the *Biquadrate*, or fourth Power, were required; the Rule is,

$$\begin{array}{ccccccccc} 4-0 & 4-1 & 4-2 & 4-3 \\ 1 \times & (=4) \times & (=6) \times & (=4) \times & (=1) \\ 1 & 2 & 3 & 4 & 5 \end{array}$$

Which shews, that the *Unciæ* are 1, 4, 6, 4, 1.

**UNCORE** *Prift*, in *Law*, is a Plea for the Defendant, being sued for a Debt due at a Day past, to save the Forfeiture of his Bond, saying, that he tendered the Debt at the Time and Place, and that there was none to receive, and that he is still ready to pay the same.

**UNCUTH**, in *Saxon*, is *unknown*, and, in the old *Saxon* Laws, is used for a Person that comes to an Inn, and lies but one Night: In which Case his Host was not answerable for any Offence he should commit, whereof he was guiltless himself. But if he lay there a second Night, then he was called a *Guest Hospes*; and then the Host was to answer for him, as for one of his Family. If he tarried any longer, he was then called *Agenbine* (or, as some write it, *Hogenbine*) and the third Night, *Awnbine*, that is, *Familiaris*: and then if he offended against the King's Peace, his Host was to see him forth-coming; and if he could not produce him in a Month and a Day, he was obliged to satisfy for his Offences.

**UNDER-Chamberlain** of the *Exchequer*, is an Officer there that cleaves the Tallies, and reads the same, so that the Clerk of the Pell, and the Comptrollers thereof, may see that the Entries be true: He also makes Searches for all Records in the Treasury, and hath the Custody of the Doom-day-Book. There are two Officers there of this Name.

**UNDIMIA**, the same with *Oedema*.

**UNGUIS**, a *Nail*, is a similar, flexible, white, and hard Part, which defends the Fingers from external Injuries, and in some measure adorns them. The Root of it is joined to a certain Ligament, and by reason of the neighbouring Tendons it becomes sensible: They seem to be made of a Collection of very little Pipes, which adhere extremely thick to one another, and shoot out into Length. Where they begin, there you find certain nervous Fibres like so many small Nipples lengthen'd, the lengthen'd Parts whereof are seen as far as the Nail: If they be forcibly torn off, they leave divers Holes, so that the Horny Substance of the Nails looks like a Net. Under the Nails there's a pappy sort of Body, which has its Vessels of Excretion.

The *Apices*, or Tops of the Nails, are they which grow beyond the Flesh; the Parts which are out, are called the *Segmina*, the Paring of the Nails; the Parts under the Nails are called *κρυπτα*, the hidden Parts; the white semi-lunar Part next the Root is the Rise of the Nail; the very Beginnings that grow into the Skin, are called the Roots

of the Nails; the Sides, the Clefts; the white Spots, *Nubeculae*, little Clouds, &c. *Blanchard*.

**UNDULATION**, in *Physicks*, is a kind of tremulous Motion or Vibration, which is observable in Liquids, or a sort of wavy Motion, whereby a Liquid alternately rises and falls like the Waves of the Sea.

**UNDULATION**, in *Surgery*, is a Term applied to the Motion ensuing in the Matter which is contained in an Abscess upon squeezing it.

**UNDULATORY Motion**, is a Motion of the Air whereby its Parts are agitated after the manner of Waves of the Sea, which is supposed to be the Matter or Cause of Sound, and the Case when the String of a musical Instrument is struck.

**UNGUIS**, the same with *Hypopycn*; which see.

**UNGUIS**, in *Anatomy*, is a Term applied to the two Bones of the Nose, being as thin as Scales, and resembling the Nail.

**UNGUIS Os**, is a little thin Bone, which lies in the great Angle of the Orbit of the Eye; it has a Hole in which the lacrymal Glands lie.

**UNGUIS**, in *Botany*, a little Speck of **UNGICULUS**, } a different Colour from the rest of the *Petala*, at the Origin or Root of them, as in the Rose, Poppy Flower, &c.

**UNGULA**, is a Sort of hooked Instrument used by Surgeons, to draw a dead *Fætus* out of the Womb.

**UNGULA**, in *Geometry*, is the Section of a Cylinder cut off by a Plane, which passes obliquely thro' the Plane of the Base and Part of the Cylindrical Surface.

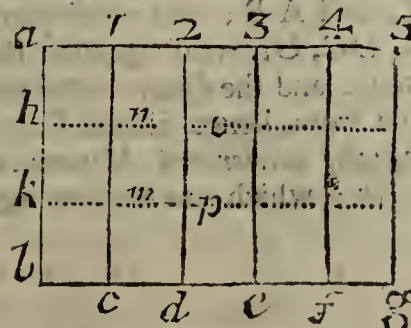
**UNIFORM Motions**, are the same with equal, or rather *Equable ones*; which see.

**UNIFORM Flowers** of Plants, the Botanists call such as are all round of the same Figure; or whose fore and back Part, and whose right and left Parts are exactly alike; but when they are not so, they call them *difform Flowers*.

### Uniform Motion.

**UNIFORM**, or *equable Motion*, and all its Properties, may be very well explained by the equiangular Parallelograms in this Figure. Where the Dirigent  $a$  represents the Time, and the Lines  $ab$ ,  $1c$ ,  $2d$ , &c. the uniform or equable Velocities with which any Body is moved, in any Parts or Moments of Times. And the *Parallelograms*  $ac$ ,  $c2$ ,  $2e$ ,  $e4$ ,  $4g$ , do truly represent the Spaces described or run through with the Velocity  $ab$ , in the Times  $a1$ ;  $1, 2$ ;  $2, 3$ ;  $3, 4$ ;  $4, 5$ .

From the bare Consideration of which only, it will follow;



1. That the *Spaces* described by any Moveable, with an equable or uniform Velocity, are always at the *Times*.



For the Parallelograms  $ac$ ,  $ad$ , &c. having all the same Altitude, must be as their Bases,  $bc$ ,  $cd$ , &c.

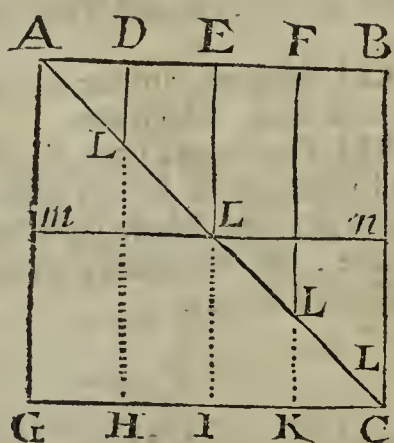
2. Or if the *Times* be equal, the *Spaces* must be as the *Velocities*; that is, the Parallelograms  $an$  to  $am$ , will be as  $ab$  to  $ak$ , &c.

3. And from hence it will follow, that if the *Spaces* are as the *Velocities*; the *Times* will be equal; if as the *Times*, the *Velocities* will be equal.

4. Where the *Spaces* are equal, the *Times* must be *reciprocally* as the *Velocities*: for the similar and parallel Rectangles have their Sides reciprocally proportionable; and, *vice versa*, where the *Times* and *Velocities* are reciprocally proportionable, the *Spaces* must be equal.

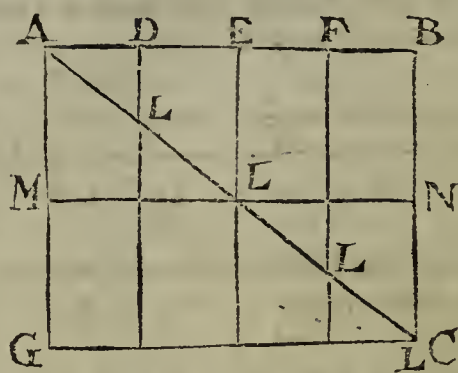
5. Wherefore the *Ratio's* of the *Spaces* are always compounded of the *Ratio's* of the *Times* and *Velocities*: And, consequently, deducting the *Ratio* of the *Time* out of that of the *Velocity*; or, which is all one, dividing the *Space* by the *Time*, there will result the *Velocity*; dividing by the *Velocity*, the *Quotient* will be the *Time*.

After much the same manner also may the uniform or equable Acceleration or Retardation of any Motion be expressed very easily and clearly by *Lines*.



As suppose the right-lined Triangle  $ABC$ , the Side  $AB$  denotes the *Time* in which a Body may move from a Point of Rest, as in  $A$ ; and having its *Velocity* continually encreasing in the uniform *Ratio* of the Lines  $DL$ ,  $EL$ ,  $FL$ , and  $BC$ ; or decreasing equally back again in the same *Ratio*, from any determinate Degree of it in  $BC$ , to none at all in  $A$ .

In this Figure then, the Triangles  $ALD$ ,  $ALE$ ,  $ALF$ , and  $ABC$ , will very appositely represent the *Spaces* described in the several *Times*  $AD$ ,  $AE$ ,  $AF$ , and  $AB$ ; and consequently the *Trapezia*  $DL$ ,  $DC$ , &c. will represent the *still aggregated Velocity*, and the *Spaces* corresponding thereunto. And from hence all the Laws and Affections of *equable accelerated Motions* will be easily accounted for; which are such as these, *viz.*

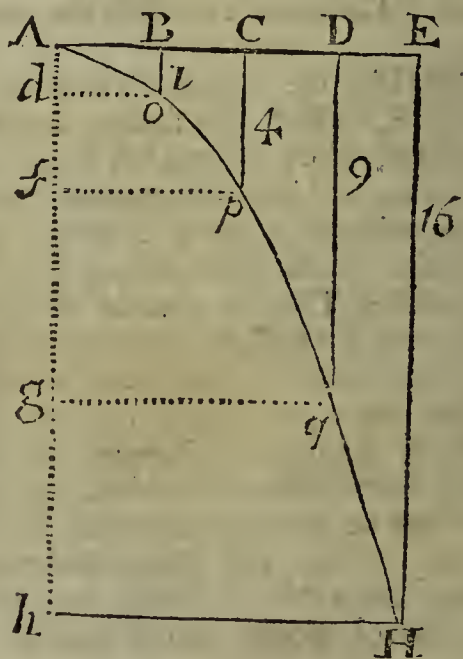


1. That the *Space* described at the end of the accelerated Motion, will be equal to that which would have been described by an uniform equal Motion in the same *Time*, and with half the Degree of *Velocity* which the accelerated Body did at last acquire: For the Triangle  $ACB$  is equal to the Square  $MB$ ; each being the half of the Square  $GB$ .

2. That the *Spaces* described by the Motion of a Body, beginning from Rest, and *uniformly accelerated*, are as the *Squares* of the *Times*. For the Areas of the similar Triangles  $ADL$ ,  $AEL$ , &c. are as the *Squares* of  $AD$ ,  $AE$ , &c.

3. And comparing divers Motions, thus *uniformly accelerated* one with another, it will be plain that the *Spaces* run thro' will be to one another in a *Compound Ratio* of the *Times*, and of the greatest *Velocities* at any time acquired, because similar Squares are in a *Ratio* compounded of that of their Sides.

4. And from hence 'tis plain, that the Case of Bodies accelerating their Motion uniformly, so as that the *Spaces* described shall be as the *Squares* of the *Times* (which is the known Case of the Descent of heavy Bodies towards the Centre of the Earth) may be very well expressed by the Complement of the *Semi-parabola*  $AEH$ ; where the vertical Tangent  $AE$  represents the determinate *Time* divided into equal Parts; and the Lines  $BO$ ,  $CP$ ,  $Dq$ , and  $EH$ , the several *Velocities* required in the several Descents. Now



the *Spaces* described,  $ABO$ ,  $ACP$ , &c. are as the *Squares* of the *Times*  $AB$ ,  $AC$ , &c. that is, as the *Squares* of the *Ordinates*  $do$ ,  $fp$ ,  $gq$ , &c. which *Squares* are (by the *Parabola*) as the *Ab-scissa*  $Ad$ ,  $Af$ ,  $Ag$ , &c.

Where-



Wherefore the *Velocities* acquir'd at the End of any Descents, will be as the Squares of the Times in which these Descents are made.

That is, the *Velocity* at the End of the second Moment, or Part of Time, to the *Velocity* at the End of the first Moment, will be as the Square of the second to the Square of the first, or as the fourth to the first, &c.

UNION, in *Architecture*, a Harmony between the Colours in the Materials of a Building.

UNION, a Term among *Painters*, is the mutual Agreeableness and Sympathy of the Colours in a Piece of Painting.

UNION. Dr. *Grew* makes Union in a Physical Sense, to be one of the three Ways of Mixture; and he defines it to be the Union of Atoms, or Particles which touch in a Plane, as in the Crystallization of Salts, and other like Bodies.

UNION, in *Musick*, is one or the same Sound, whether produced by one single Voice, or divers Voices sounding in the same Tone; so that an *Unison* in this Science may be considered as an Unite in Arithmetick, or as a Point in Geometry, not divisible into any Parts, in regard that it is the first Term to any Interval. When the Ancients divided their *Monochord*, so that the Parts were as 1 to 1, they called them *Unisons*.

UNION of two Churches, is a consolidating or combining them into one, which may be done by the Consent of the Bishop, Patron, and Incumbent. See *Linwood's Provincials*, and 37 H. 8. c. 21. as also 17 Car. 2. c. 3.

UNISONS. It hath been long since observed, that if a Viol-string, &c. be struck with the Bow or Hand, another String on the same, or another Instrument not far from it, will (if an Unison to it) tremble at the same Time of its own Accord. But Dr. *Wallis*, in *Philos. Trans.* N<sup>o</sup>. 134. tells us, that 'tis not the Whole of the unstruck String that trembles, but the several Parts severally, according as they are Unisons to the Whole, or the Parts of that String which is so struck: *v. gr.* If one String be an upper Octave to another, and therefore an Unison to each half of it when 'tis stopt in the middle; then, I say, if the former be struck while the latter is open, the two Halves only of the latter will tremble, and not the middle Point; as you may easily try, by laying a Bit of Paper lightly wrapt about the middle of the second String. See a Solution of this in *Plot's Hist. of Oxfordshire*, by Dr. *Narcissus Marsh*, and of other such Phænomena.

UNITE, is the same with the Figure 1, being one single individual Part of discreet Quantity. If a Number consist of 4 or 5 Places, that which is outermost towards the Right-hand, is called the *Place of Unites*.

Number in general, is by *Euclid* defined to be *ποσάδα ποσότης*, a Multitude, or Aggregate of *Unites*; and in this Sense *Unity* is not a Number. But *Unity*, as it may be taken for an individual *Unite*, is certainly as much a Number as 10, 20, 100, &c.

UNITY of Possession, in the Civil Law, is called *Consolidatio fructus & proprietatis*, and signifies Joint Possession of two Rights by several Titles.

As for Example: If I take a Lease of Land from one upon a certain Rent, and afterwards I buy the Fee-simple, this is an *Unity of Possession*, by which the Lease is extinguished, by reason that

I, which before had the Occupation only for my Rent, am become Lord of the same, and am to pay my Rent to none but my self.

UNIVERSAL *Equinoctial Dial*, is made of two Rings of Brass or Silver, that open and fold together, with a Bridge or Axis, and a Slider, and a little Ring to hang or hold it up by: It is divided on one side of the great Ring into 90 Degrees, and sometimes on the other into two Quadrants, or 180 Degrees, but one is enough: The innermost Ring is divided into 24 Hours, sub-divided on the Face, and on the Outside of the Ring, into every five Minutes. The Axis has the Sun's Declination on one Side, and the Days of the Month and the Sun's Place on the other.

To use it for the Hour, the Perpendicular Line or Stroke which is on the Slider, which moves on the outer Ring, must be set to the Latitude of the Place, and the Hole in the Slider on the Bridge either to the Sun's Place in the Ecliptick, the Day of the Month, or his Declination; and then the Rings being opened, and set square to one another, move the Dial about to and fro, till the Sun shines through the Hole, and on the inner Edge of the innermost Ring, and there it will shew the true Hour.



UNIVOCAL Terms in Logick, are such whose Name and Nature is the same; and 'tis used in Opposition to Equivocals, whose Names are the same, but their Natures very different; for a Thing to be predicated *Univocally* of any others, is to be attributed to all of them alike, and in the same proper Sense.

UNIVOCAL *Generation*, with the *Ancients*. The Doctrine they held, was, that all perfect Animals were produced by *Univocal Generation*, i. e. by the sole Union or Copulation of Male and Female of the same Species or Denomination: But that Insects were produced by *Equivocal Generation*, without any Seed, but merely by the Corruption of the Earth exalted, and as it were impregnated by the Rays of the Sun.

UNLAWFUL *Assembly*, is the Meeting of three or more Persons together by Force, to commit some *unlawful Act*, and so abiding together, tho' not endeavouring the Execution of it, as to assault, or beat any Person, to enter into his House or Land, &c.

UNLIKE Quantities and Signs in *Algebra*: See like Signs and Quantities.

UNLIMITED Problem (*Inordonné*) according to Mr. *Ozanam*, is such a Problem in *Mathematics*, as is capable of *Infinite Solutions*: As to divide



vide a Triangle given into two equal Parts, to make a Circle pass through two Points assigned, &c.

UNMOOR, a Term used at Sea for a Ship that before *rid*, or was held by two Anchors, to begin to get them up, and prepare to *weigh*. See *Moor*.

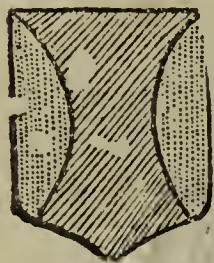
UNQUES *Prist*, in Law, is a Plea whereby a Man professeth himself *always* ready to do or perform that which the Defendant requires: As if a Woman sues the Tenant for her Dower, and he coming in at the Day, offers to aver, That he was *always ready*, and still is to perform it. In this Case, except the Demandant shall aver the contrary, he shall recover no Damages: When this Plea will serve to avoid Charges, and when not: See *Kitchen*, fol. 243.

VOCAL *Nerves*, the same with *Recurrent*; which see.

VOID *Bastion*: See *Bastion*.

VOIDANCE, in Canon Law, Vacancy, the Want of an Incumbent upon a Benefice.

VOIDED, a Term in Heraldry, when there are Lines drawn within, and parallel to the Out-lines of any Ordinary: This expresses an Exemption of something of the Thing voidable, and makes the Field appear transparent through the Charge.



VOIDER, so the Heralds call one of the *Ordinaries*, whose Figure is much like that of the *Flasque* or *Flanch*, only it does not bend or bow in so much: This Armour, they say, is the Reward of a Gentlewoman that has well served her Prince. They are al-

ways born by Pairs.

The Field is *Tenn*, two *Voiders*, Or.

VOIR *dire*, is when 'tis pray'd upon a Trial at Law, that a Witness may be sworn upon *Voir dire*; the Meaning is, he shall upon his Oath speak or declare the Truth, whether he shall get or lose by the Matter in Controversy; and if he be unconcern'd, his Testimony is allow'd, otherwise not.

VOL, in French Heraldry, a Term used of a Bird in a Coat of Arms drawn flying, or having its Wings spread out.

VOLATILE Salt of *Vegetables* is usually drawn into a Retort from the Fruits or Seeds fermented, and seems to be only the *Essential Salt* driven up higher, and Volatilized by the Spirits during the *Fermentation* and *Distillation*.

The *Volatile Salt* of *Animals*, is drawn much the same Way as that of *Vegetables*.

VOLATILE Spirit of *Sal Armoniack*, is made either by mixing Quick-lime, or Salt of *Tartar*, with *Sal Armoniack*, and then pouring a sufficient Quantity of Water upon it, the Matter is distilled in a Retort, when Quick-lime is used, otherwise in a Glass Body or Cucurbite; by this means the Lime or the Salt of *Tartar* doth destroy the Strength of the Acid Sea-Salt, that held bound and fix'd the *Volatile Salts* of *Urine* and *Soot*, of which *Sal Armoniack* is made; whereby they being at Liberty, are driven out by the Fire, and dissolved in the Water that was poured on the Mixture, and so compose this *Volatile Salt*.

Spirit of *Sal Armoniack* made with Quick-lime, is an excellent Thing to make Precipitations with; destroying all kinds of Acids almost, and is used to precipitate Solutions of Gold.

If you mix together equal Parts of this Spirit, made with *Tartar*, and of Spirit of Wine, a *Coagulum* will arise on their being shaken together; but not if you use the Spirit of *Sal Armoniack* made with Quick-lime.

If after either of these Mixtures to make Spirit of *Sal Armoniack* be put into the Body or Retort, Spirit of Wine be poured on, and then the Spirit drawn off; this is called Spirit of *Sal Armoniack* dulcified.

VOLATILE Spirit, is a *Volatile Salt* dissolved in a sufficient Quantity of Phlegm or Water.

VOLATILES, are (by some made) a Species of Animals, which fly in the Air as Birds do.

VOLATILITY, is the Property of such mix'd Bodies, whose Corpuscles or Particles, of which they are composed, will rise up by that Degree of Heat, as is proper to sublime it.

Mr. Boyle, in his Notes upon the Mechanical Production of this Quality of *Volatility*, supposes, or rather proves, these four Attributes or Qualifications, requisite to denominate a Body volatile.

1. That its constituent Particles, or Corpuscles, be very small; for besides that such minute Parts are more easily put into Motion by the Action of Fire and Heat, and consequently are more apt to be elevated than other Parts which are more gross; these can continue their Motion upwards with less Resistance, and with a less Tendency to descend down by their own Gravity. Wherefore,

2. 'Tis necessary that the Corpuscles of Volatile Bodies should not only be very small, but they must also not be too solid and heavy; for the great Specifick Weight of such Bodies will hinder them from rising.

3. 'Tis necessary also, that they be conveniently shaped for Motion; for if they be of hooked, branched, or any other irregular and catching Figure, tho' they may be both very small and light, yet they will be apt to be entangled one in another, or to hang or stick to other Bodies; and this probably is the Reason why Water is more easily elevated by Heat, and brought to exhale, than Oil, tho' it be specifically heavier than it, and its likely hath its Parts smaller too.

4. 'Tis necessary that the Parts do not too closely adhere to one another, so as on that account to be indisposed for the Separation by the Heat of an ordinary Degree of Fire.

And this Honourable Gentleman largely shews, that this Quality of *Volatility* is producible by such Mechanical Means as will produce some or of all the Qualifications abovementioned.

VOLATILIZATION, in Chymistry, is the Art of rendering fix'd Bodies volatile, or of resolving them by Fire into a fine subtil Vapour or Spirit, that easily dissipates and flies away.

VOLITION, is an Act of the Mind, knowingly exerting that Dominion it takes itself to have over any Part of the Man, by employing it in, or with-holding it from, any particular Action.

VOLSELIA, or *Vulsella*, is an Instrument to pull up Hairs with by their Roots, the same with Tweezers, or a Chyrurgeon's little Tongs, which are



are of different Shape according to the Diversity of their Use.

**VOLVA**, the great *Kepler* considering how our Earth will appear to the Inhabitants of the Moon, if there be any such, *viz.* that it will seem a large Moon to them 15 times greater than their Planet doth to us at the Full, in 25 Hours time *revolving* round its Axis (as will be easily discovered by the Spots that must appear in it) but yet also fixed like a fixed Star in one determinate Place in the Heavens, and moving only as they appear to do; this being the Phænomenon of the Earth to a Lunar Spectator (*i. e.* to such as live on that side of the Moon, which is always turned towards the Earth; for those in the other Hemisphere can never see the Earth at all) he fancies that they would give it a Name something like that of *Volva*; and while they would consider their own Earth as a *Vesta*, an immoveable Seat or Habitation. In pursuance of this imaginary State of Things, *Kepler* calls the Inhabitants that live in that Half of the Moon's Sphere, which is turned towards the *Volva*, *Subvolvæ*; and the others that never see the Earth, *Privolvæ*.

**VOLUMUS**, is the first Word of a Clause in the King's Writs of Protection and Letters-Patents.

Of Protections, some are *Cum clausula Volumus*; and of these there are four Kinds, *viz.*

1. *Quia Profecturus.*
2. *Quia Moraturus.*
3. *Quia indebitatus nobis existit.*
5. When any one sent out into the King's Service beyond Sea in War, is imprisoned.

**VOLUNT**, a Law Term, is when the Tenant holds at the Will of the Lessor, or Lord, and that is in two ways.

First, When I make a Lease to a Man of Lands to hold at my Will, then I may put him out when I please; but if he sow the Ground, and I put him out, then he shall have his Corn with Egres and Regres, 'till it be ripe to cut and carry it out of the Ground; and such *Tenant at Will*, is not bound to repair and sustain the House, as a Tenant for Years is: But if he make wilful Waste, the Lessor shall have against him an Action of *Trespas*.

The other *Tenant at Will*, of the Lord, is by Copy of Court-Roll, according to the Custom of the Mannor; and such a Tenant may surrender the Land into the Hands of the Lord, according to the Custom, to the Use of another for Life, in Fee, or in Tail; and then he shall take the Land of the Lord, or his Steward, by Copy, and shall make Fine to the Lord.

**VOLUTA**, in *Architecture*, is that Part of the Capitals of the *Ionick*, *Corinthian*, and *Composit* Orders, which is supposed to represent the Bark of Trees twisted, and turned into Spiral Lines; or, or as some say, the Head-dresses of Virgins in their long Hair. *Voluta's* are different in these three Orders: Those that appear above the Stems in the *Corinthian* Order (according to *Vitruvius*) are 16 in Number in every Capital; whereas there are only 4 in the *Ionick* Order, and 8 in the *Composit*. But these *Voluta's* are more especially remarkable in the *Ionick* Capital, representing a

kind of Pillow or Cushion laid between the *Abacus* and the *Echinus*, as if it were to be feared lest the Weight of the *Abacus*, or of the *Entablature* above it, might break or deface the *Echinus*; whence the same ancient Architect took Occasion to call the *Voluta*, *Pulvinus*, or Bolster.

**VOLVULUS**: See *Ileon* and *Gbordapsus*.

**VOMER**, is a Bone situated in the Middle of the lower Part of the Nose. It has a Cleft in the upper Side, in which Cleft it receives the lower Edge of the *Septum Nasi*. In its further End it receives a small *Apophyse* of the *Sphænoïdes*, and its under Side joins the *Os Palati*.

**VOMICA**, is a Fault in the Lungs, from Heterogeneous Blood, which lodged prehaps in one of the little Bladders, or Cells there, occasions neither a Fever nor a Cough; but afterwards, when it is encreased, it oppresses the neighbouring Sanguiferous Vessels, and impregnates the Blood as it passes along with its *Effluvia*; whereupon there succeeds a small Fever, accompanied with Inquietude and Leanness; at last, when it is full grown and concocted into Matter, it makes a Nest as it were, and lodges there. *Blanchard*.

**VOMITIVE** Medicines, see *Emeticks*; where there is an Account of their Operation.

**VORTEX**, in *Meteorology*, a Whirl-wind, a sudden rapid, violent Motion of the Air in Gyres or Circles. *L.*

**VORTEX**, according to the *Cartesian* Philosophy, is a System of Particles of Matter moving round like Whirl-pool, and having no void Interstices, or Vacuities between the Particles. This Vortex, thus moving round, will occasion any Bodies that swim in the System, to move round as that doth, and that swifter or slower, according as they are farther off, or nearer to the Centre.

By such *Vortices* as these, they endeavour to solve the Motion of the Heavenly Bodies round the Sun in the Centre of the Vortex. But the Excellent Sir *Isaac Newton* hath demonstrated, that the Planets cannot be carried round their Centre by the Motion of any *Corporeal Vortex*: Because if they were, the Vortices themselves must be carried round after the same manner, as Astronomers have discovered, that the Planets perform their Revolutions; which is so, that their Periodical Times are always in a *Sesquialteral Ratio* of their Distances from their Centres; or that the *Squares of the Times of their Periodical Revolutions are as the Cubes of their middle Distances from their Centres*.

But he proves, that the Periodical Times of the Parts of the Vortex will always be only as the Squares of their Distances from the Centre of their Motion:

Besides, the Planets, according to the true *Copernican Hypothesis*, being carried about the Sun in Ellipses, and having the Sun in the *Umbilicus* of each Figure, by Lines drawn from themselves to the Sun, do always describe Areas proportional to the Times of their Revolutions, which he shews the Parts of no Vortex can do: See *Scol. Prop. ult. Lib. 2. Princip.*

Again, as the Ingenious Mr. *Keil* observes in his Examination of Dr. *Burnet's Theory*: If the Earth were carried in a Vortex, it would move faster, in the Proportion of 3 to 2, when it is in *Virgo*, than when it is in *Pisces*, which all Experience proves to be false: See a large Refutation of all the *Cartesian*



*tesian* Doctrine of the Vortices in Dr. Gregory's *Astronom. Phys. & Geometr. Lib. 1. Sect. 10.*

**VOUCHER**, is a Term in Law, signifying when the Tenant calls another into the Court, that is Bound to him to Warranty: And 'tis either to defend the Right against the Demandant, or to yield him other Lands, &c. in Value, and extend to Lands or Tenements, of Freehold or Inheritance: And it seems in some measure to agree to the Contract in the Civil Law, whereby the Vendee bindeth the Vendor, sometimes in the simple Value of the Things bought, sometimes in the double, to *Warrant* the secure enjoying the Thing bought; yet there is this Difference between the *Civil* and the *Common Law*, that the *Civil Law* binds every Man to warrant the Security of that which he selleth, which the *Common Law* doth not, except it be specially covenanted.

The Process whereby the *Vouchee* is called, is a *Summoneas ad Warrantifandum*: And if the Sheriff return upon that Writ, that the Party hath nothing whereby he may be summoned, then goes out another Writ, called *Sequentur sub suo periculo*.

A Recovery with a *single Voucher*, is when there is but *one Voucher*: And with a *double Voucher*, is when the *Vouchee* voucheth over, and so a *treble Voucher*.

There is also a *Foreign Voucher*, when the Tenant being impleaded in a particular Jurisdiction of that Court, which might more aptly be called a *Voucher* of a Foreign.

*Voucher* signifies also a Leiger-Book, or Book of Accompt, wherein are entred the Acquittances or Warrants for the Accomptant's Discharge.

**VOUSSOIR**, in *Architecture*, a *Vault-Stone*, or that which forms the Sweep of an Arch, being cut somewhat in the manner of a Truncated, the Sides of which, if they were prolonged would terminate in a Centre, to which all the Stones of the Vault are directed.

**VOYDANCE**, is a Want of an Incumbent upon a Benefice, and this double, either *in Law*, as when a Man hath more Benefices incompatible; or in *Deed*, as when the Incumbent is dead, or actually deprived.

**UPRIGHT**, in *Architecture*, a Representation, or Draught of the Front of a Building.

**UPRIGHT South Dials**: See *Prime Verticals*.

**URACHUS**, is one of the Umbilical Vessels, being a small membranous round Pipe, with a very streight Cavity arising from the bottom of the Bladder up to the Navel, out of which it passes along with the common Cover, and opens into the *Allantoides* of the *Fætus*: 'Tis more pervious in some of the larger Brutes than in Men, in whom some have denied it to be hollow; but that seems contradicted by the Instances we have had of Mens making Water by the Navel, when the Passage of the *Penis* hath been quite stopped. *Bartholin* and some others say, that the *Urachus* in Men reaches no farther than the Navel: But how then comes that Humour into the *Allantoides*, which has perfectly the same Taste with the Urine in the Bladder? The Mistake seems to arise from that wrong Notion, that a Human *Fætus* hath no *Allantois*, which hath been by *Needham* and others sufficiently refuted.

The Use of the *Urachus* is to convey the Urine from the Bladder of the *Fætus* into the *Allantoides*, which is placed between the *Chorion* and the *Amnion*.

**URBICARIÆ** *Regiones*. See *Suburbicariæ*.

**URDEE**, in *Heraldry*, as a *Cross*, *Urdee*, is much the same that is otherwise called *Clechee*.

**URENTIA**, in *Surgery*, Medicines of a hot and burning Quality. *L.*

**URETER**, is a Fistulous Membranaceous Vessel, which proceeds from both Reins, and opens between the Membranes of the Bladder, by which the Urine passes from the Reins to the Bladder; *Celsus* calls it the white Vein.

**URETHRA**, or *Fistula*, is the Urinary Passages, whereby the Urine is discharged: It serves in Males also for the Ejection of the Semen. The Seminal little Bladders empty themselves into it by 2 Holes at the beginning of it, when there is occasion; which Bladders or Vessels are surrounded with Glandulous Prostates, perforated with several Holes, to which there is a little piece of Flesh affixed. *Blanchard*.

Mr. *Cowper* observes, That the *Urethra* hath a *Corpus Cavernosum*, like to that of the *Penis*, which you will find described under the Words *Corpora Cavernosa*; but this of the *Urethra* differs much in Figure from them: The superior Part of this *Corpus Cavernosum* lying between the two *Crura* of the former, he calls *Bulbus*, from its Figure; it is covered with the *Musculus Accelerator Urinæ*; it possesseth all the lower Part of the *Urethra*, extending its self in the *Perinæum*; it hath, moreover, a *Septum Intermedium* (tho' not taken Notice of by Anatomists) dividing the right Side of the *Bulbus* from the left, which descending to the End of the bulbous Part, is there obliterated.

The Use of this *Septum* is (as Mr. *Cowper* thinks) to direct the reflux Blood to the exporting Ducts, its two Veins that carry the Blood back.

As this *Corpus Cavernosum* descends on the inferior Part of the *Urethra*, it is lessened; but when it approaches the Extremities of the two other *Corpora Cavernosa*, it again dilates it self and covers them, composing that Body which they call the *Glans* or *Balanus*.

**URIGO**, in *Surgery*, a burning with a Cautery stick or Cautery.

**URINAL**, a Vessel fit to receive and hold Urines.

**URINARIA** *Tustula*, in *Anatomy*, the same as *Urethra*, so called from its Office to convey the Urine.

**URINOUS** *Salts*, are that Tribe of Volatile Salts drawn from Animal or other Substances that are contrary to Acids: And Mr. *Boyle* says, they are distinguishable from *Lixivate* Salts, by this Test, That they will turn a Solution of Sublimate into a white Colour, whereas *Lixivate* Salts turn it into a Yellow one.

**URN**, in *Architecture*, a Vase of a roundish form, but bigger in the middle like our common Pitchers, used by way of Acroters on the top of Buildings, funeral Monuments; and these were used by the Antients to preserve the Ashes of the Dead after they were burnt.

**URSA Major**, a Northern Constellation, consisting of 27 Stars, and is otherwise called *Charles's Wain*, and the *Great Bear*.

**UROCRITERIUM** [*of ὕρως, Urine, and κριτήριον, Mark or Sign, Gr.*] a casting of Water; a giving a Judgment of Diseases by the View of the Urine.

**USAGE**: See *Prescription*.

**USE**,



USE, in Law, properly signifies the Profits or Benefits of Lands or Tenements: For every Deed consists of 2 principal Parts; namely, *The Premises*, and *the Consequents*.

*The Premises*, is the former Part thereof, being all that which precedeth the *Habendum*, or Limitation of the Estate, which are the Persons contracting, and the Thing contracted.

*The Consequent* is that which follows the *Premises*, and that is the *Habendum*, in which are two Limitations: The one of the Estate or Property, which the Party Passive shall receive by the Deed: The other of the *Use*; which is to express in the said *Habendum*, to or for what *Use* and Benefit he shall have the same Estate, and of the Limitation of such *Uses* many Precedents are set down in Law-Books.

USE and CUSTOM, in *Old Law-Books*, is the ordinary Method of acting or proceeding in any Case, which by Length of Time has obtain'd the Force of a Law.

USE in the *Civil Law*, is one of the *Personal Services*, and signifies a Right that a Man hath of using a corporeal Thing belonging to another, without Prejudice to the Proprietor of it: This Right is not so great as an *Usufruct*; for he that hath this Right, cannot take the Profits generally, but only for his daily Use and necessary Subsistence.

USER *de Action*, a Term in Law, signifying the pursuing or bringing an *Action*, which in what Place and Country it ought to be: See *Bro. tit. Lieu and Country. Fol. 64.*

USHER, *Ostiaris*, from the *French Huissier*, a Door-keeper of a Court, is an Officer in the Exchequer, of which fort three or four attend the chief Officers and Barons at the Court at *Westminster*; and Juries, Sheriffs, and all other Accomptants, at the Pleasure of the Court. There are also *Ushers* in the King's House, as of the Privy-Chamber, &c.

USUCAPTION, in Law, signifies the enjoying a Thing by Continuance of Time, or receiving the Profits, long Possession or Prescription.

USURY, is the Gain of any Thing above the Principal, or that which was lent; exact only in Consideration of the Loan, whether it be Money, Corn, Apparel, Wares, or such like.

USUFRUCT, is a Personal Service, whereby a Man hath a Right of using and taking all manner of Profits of a corporeal Thing belonging to another Person, so it be without Diminution or Prejudice to the Propriety of it; and he that hath this Right is called an *Usufructuary*.

UTAS *Octava*, in the Law, is used for the eighth Day following any Term or Feast; as the *Utas* of St. Michael, of St. Hillary, of St. John Baptist, &c. and any Day between the Feast and the Octave, is said to be within the *Utas*. The Use of this is in Return of Writs, as appears by 51 H. 3. and Preamble to 43 E. 3.

UTERINUS *Furor*, with *Physicians*, is a Complication of Hysterical Symptoms, which proceed from a Turgescency or Inflation of the *Uterine Vessels*; it is a kind of Frenzy attended with lascivious Gestures and Speeches, and an invincible Inclination to Venery.

UTERUS, the Womb, an Organical Part, wherein Generation and Conception are made,

UTFANGTHEF, *Fur extra captus*, is an ancient Privilege or Royalty granted to a Lord of

a Manor by the Sovereign, giving him a Power to punish a Thief dwelling out of his Liberty, and committing the Theft also without the same, if so be that he be taken within the Fee of that Lord.

UTLAGATIO *Viri*.

UTLAGATO *capiendo quando utlagatur in uno comitatu & postea fugit in alium*, is a Writ, the Nature whereof is sufficiently expressed by the Name.

UTLARY, or *Utlawry*, is a Punishment for such as being called into Law, and lawfully fought, do contemptuously refuse to appear after an *Original Writ*, with a *Nihil habet*, three Writs of *Capias*, *Alias* & *Plures*, returned by the Sheriff *non est inventus*, and an *Exigent* with a *Proclamation* thereupon awarded. And *Bracton* says, he must be called at five Counties, a Month between every County; and if he appear not within that Time, he shall be pronounced out of the King's Protection, and deprived of the Benefit of the Law. The Effect of this is divers; for if he be *Outlawed* at the Suit of another in a civil Cause, he shall forfeit all his Goods and Chattels to the King. If upon Felony, then he shall forfeit all his Lands and Tenements, which he hath in Fee, or for Life, and his Goods and Chattels. A Minor nor Woman cannot be *Outlawed*: For where a Man is said to be *Outlawed*, a Woman is termed *Waived*.

UTRUM: See *Affise*.

UTTER-BARRISTERS, are such, who for their long Study, and great Industry bestowed upon the Knowledge of the Common Law, are called from their Contemplation to Practice, and, in the Face of the World, to take upon them the Protection and Defence of Clients. The Time before any ought to be called to the Bar, was formerly eight Years, but now reduced to seven; and the Exercises done by him (if he were not called *Ex gratia*) was Twelve *Grand Moots* performed in the Inns of Chancery, in the Time of the Grand Readings, and Twenty-four *Petty Moots*, at the Inns of Chancery, in the Term-times, before the Readers of the respective Inns of Chancery.

A *Barrister* newly called, is to attend the six next long Vacations, the Exercises of the House, viz. in *Lent* and *Summer*, and is therefore for those three Years called a *Vacation-Barrister*.

And they are also called *Utter-Barristers*, i. e. Pleaders without the Bar, to distinguish them from Benchers, or those that have been Readers, who are sometimes admitted to plead within the Bar, as the King's, Queen's, or Prince's Council are.

UVA, the same with *Cion*; which see.

UVEA, this is reckoned the fifth Coat of the Eye, and seems to be only the Circumference of the *Pupilla*; it is composed of circular and streight Fibres, to contract and dilate according to the Strength or Weakness of the Light; for when the Light is too strong, the circular Fibres contract the *Pupilla*, that the Force of the Rays may not hurt the Eye; and when the Light is too weak, the streight Fibres dilate the *Pupilla*, to let in more Rays, in order to form the Vision of Objects more distinctly.

UVEA *Membrana sive Tunica*, is the Fore-part of the *Choroides*; being almost altogether continuous on the Inside to the *Tunica Sclerotis*: It is perforated in the Fore-part, and leaves a Space for the Apple of the Eye, which may be contracted or dilated: Its exterior Surface is of various Colours, whence



whence, it is called *Iris*, and in this is the Difference of Mens Eyes as to Colour; as Black, Grey, &c. The Inside of this Uveous Tunick is cover'd with a Black Lining, that the Cavity of the Eye may be the darker.

UVIGENA, or UVIGERA, the same with *Cion*.

VULGAR *Fractions*: See *Fractions*.

VULNERARY, *Vulnerarius*, *L* of or pertaining to, or good for Wounds, as Vulnerary Medicines.

VULTUR *Volans*: See *Aquila*.

VULVA, in *Anatomy*, the Uterus or Womb, *L*.

VULVA *Cerebri*, in *Anatomy*, an oblong Furrow in the Brain, so called from its Resemblance in Form to a Female *Vulva*.

UVULA, is a double Production of the Internal Membrane of the Mouth; its Substance is very lax, and it has a Number of small Glands as in the Palate: It is somewhat long and of a Conick Figure: It hangs from the Roof of the Mouth near the Passage which comes from the Nose, above the Seat of the Larynx between the Tonfils: It is moved by 2 Pair of Muscles, called *Pterigostaphilinus Externus & Internus*: Its Use is to hinder Drink, &c. from falling down into the *Aspera Arteria*.

## W A G

## W A L

**W**ADDING, with *Gunners*, a Stopple of Hay, Straw, Paper, old Clouts, &c. thrust into a Cannon, &c. upon the Powder, to keep it close in the Chamber, or put up close to the Shot to keep them from rolling out.

WADHOOK, among the *Gunners*, is a Rod or great Wire of Iron, turn'd in a Serpentine Manner; and in its End is put upon a Handle or Staff, to draw out *Wads* or *Okum*, that the Piece may be unloaded.

WAFT: To waft a Ship, is to convey her safe, as Men of War do by Merchants Ships. But to *make a Waft*, is to hang out some Coat, Sea-gown, or the like, in the main Shrowds of the Ship, as a Sign for Men to come on Board, &c. And often such a *Waft*, is a Sign a Ship is in great Danger by a Leak, &c. and therefore wants Help from the Shore, or from some other Ship.

WAIFE, or *Weyfe*, is, when a Thief having feloniously stolen Goods, and being nearly followed with *Hue and Cry*, or else overcharged with the Burden or Trouble of the Goods, for his own Ease and more speedy Flight, flies away and leaves the Goods behind him; then the King's Officer, or the Bailiff of the Lord of the Manor (within whose Jurisdiction they be left) who by Prescription or Grant from the King, hath the Franchise of *Waife*, may seize the Goods so wav'd to his Lord's Use, except the Owner come with fresh Suit after the Felon, and sue an Appeal within a Year and a Day, or give Evidence against him at his Arraignment, &c. In which Cases, the first Owner shall have Restitution of his Goods so stolen and *waived*: *Waifes* also signify Things lost, and Estrays, which must by the Lord of the Franchise where they are found, be caused to be Cried and Published in Markets and Churches near about, else the Year and Day does not run to the Prejudice of the Loser.

WAGA, or VAGA, the same with *Weight*, which see in this *Vol*.

WAGE, *Vadiare*, from the *French Gager*, *da-re Pignus*, signifies in our Law the giving Security for the Performance of any Thing: As to *wage Law*, is to put in Security, that you will *make Law* at a Day assigned; and to *make Law*, is to take an Oath that a Man owes not a Debt

which is claimed of him, and also to bring with him so many Men as the Court should assign, to avow on their Oaths, that they believe he swears truly.

WAGER of *Law*: See *Law*.

WAGONER: See *Charles's Wain*.

WAIVE, is a Woman that is Outlaw'd; and she is called *Waive*, as forsaken of the Law, and not an *Outlaw*, as a Man is; for Women are not sworn in Leets to the King, nor to the Law, as Men are, who therefore are within the Law; whereas Women are not, and for that Cause they cannot be *Outlawed*, since they never were within it.

WAIKE of a Ship, is the smooth Water that runs from a Ship's Stern, when she is under Sail. This is also called her Wake; and by it a good Guess may be made of the *Speed* she makes. And particularly, they judge from this *Wake*, whether a Ship go *as she looks*, (as they expect it) *i. e.* whether she makes her Way right as her Head lies, as she doth when her *Wake* is *right a-Stern*: But if this *Wake* be a Point or two to Leeward, they judge that she slides and falls to the *Leeward* of her Course.

They say also, when a Ship *stays a Weather* of *Wake*; that is, when in her Staying, she is so quick, that she don't fall to Leeward upon a Tack, but that when she is tack'd, her *Wake* is to Leeward; then 'tis a Sign that she feels her Helm very well, and is nimble of Steerage.

Also, when one Ship giving Chase to another, is got as far into the Wind as she, and falls directly after her, they say, *She is got into her Wake*.

WALE, or *Wail*; a Term at Sea for those outmost Timbers in a Ship's Side, on which Men set their Feet when they clamber up a Ship's Side. These are reckoned from the Water, and called her 1st, 2d, or 3d *Wale* or *Bend*.

WALE-Knot, is a round Knot or Knob made with three Strands of a Rope, so that it cannot slip, by which (in a Ship) the *Tacks*, *Top-sail Sheets*, and *Stoppers* are made fast: As also, some other Ropes.

WALE-Reared; so the Seamen call a Ship, when after she comes to her Bearing, she is not narrow in her upper Work, nor *housed in*, as their Word is, but



but is built freight up. Which Way of Building, tho' it don't look well, nor is, as they say; *Ship-shapen*, yet it hath this Advantage, that a Ship is thereby more *Roomy* within-board; that is, she is larger within, and also becomes thereby a *Hol-som Ship in the Sea*, especially if her Bearing be well laid out.

WALT; a Ship is *Walt*, when she hath not her due Ballast, *i. e.* not enough to enable her to bear her Sails.

WALVIARIA *Mulieris*, a Term in Law, signifying as much as *Utlagatio Viri*, or the Outlawing of a Man: See *Utlagation*.

WAPP, is that Rope in a Ship wherewith the Shrowds are set taught with Wale-knots; one End is made fast to the Shrowds, and to the other are brought the Laniards.

WARD, is a Word that has divers Significations; as a *Ward* in *London*, is a Portion of the City committed to the special Charge of one of the Aldermen of the City. Also, a Forest is divided into *Wards*. And a Prison is called a *Ward*. As also, the Heir of the King's Tenant that held by Knight's Service, or in *Capite*, was called a *Ward* during his Nonage. But this last is taken away by the *Stat. 12 Car. 2. cap. 24.*

WARDAGE, the same with *Ward-penny*.

WARDECORN, is the Duty of keeping Watch and Ward with a Horn to blow, on any occasion of Surprize, &c.

WARDEN, being the same with Guardian, yet is commonly used for him that hath the Custody and Charge of any Person or Thing, by Office.

WARD-PENNY, *Warpen Warth-penny*, *Warscot*, *Warth*, was formerly a customary Due paid to the Sheriff, and other Officers, for maintaining Watch and Ward; it was payable at the Feast of *St. Martin*. This customary Acknowledgment is still paid within the Mannor of *Sutton-Colfield*, in *Warwickshire*; and with some Ceremonies that are as singular as surprizing. *Cowel's Interp.*

WARDMOTE, in *London*, is a Court so called, and which is kept in every Ward.

WARDEN of the *Mint*: See *Master*.

WARDS and *Liveries*, was a Court first erected by King *Hen. VIII.* and afterwards augmented by him with the Office of *Liveries*: But 'tis now absolutely taken away and abolished, by a Statute made *12 Car. 2. cap. 24.*

WARD-STAFF, was formerly the Term for a Constable's Watchman's Staff: And the Mannor of *Lamborn* in *Essex*, is held by *Service of the Ward-Staff*, *viz.* to carry a Load of Straw in a Cart, with six Horses, two Ropes, and two Men in Harness, to watch the *Ward-Staff*, when it is brought to the Town of *Aibridge*.

WARNING-Wheel, in a Clock, is the *Third* or *Fourth Wheel* (according to its Distance from the *First Wheel*.)

WARP; to warp a Ship, is to hale her up by a Hawser, or any other Rope (sufficient for that purpose) with an Anchor bent to it. It's used when a Wind is wanted to carry her into, or out of a Harbour; and this is termed Warping; and the Hawser, or any Rope sufficient, and used to hale her up, is called a Warp.

WARRANT of Attorney, is that whereby a Man appoints another to do something in his Name, and warranteth his Action. It seems to differ from a *Letter of Attorney*, which passeth usually under the Hand and Seal of him that

makes it before any creditable Witnesses; whereas a *Warrant of Attorney*, in Personal, Mixt, and some Real Actions, is put in of course by the Attornies for the Plaintiffs or Demandants, Tenants or Defendants. But a *Warrant of Attorney* to suffer a common Recovery by the Tenant or Vouchee, is acknowledged before such Persons, as a Commission for the doing thereof directs.

WARRANTIA *Custodiæ*, is a Writ judicial; and formerly, before the Court of Wards was abolished, lay for him who was challenged, when a Ward to another, in respect of Land said to be holden in Knight-Service; which when it was brought by the Ancestors of the *Ward*, was warranted to be free from such Thralldom; and it lay against the *Warranter* and his Heirs.

WARRANTIA *Chartæ*, is a Writ that lies for him, who being infeoffed in Lands or Tenements with a Clause of Warrantry, and is impleaded in an *Affize*, or *Writ of Entry*, wherein he cannot Vouch or Call to *Warranty*: For in this Case his Remedy is to take out this Writ against the Feoffer or his Heirs.

WARRANTIA *Diei*, is a Writ lying in Case where a Man having a Day assigned personally to appear in Court to any Action wherein he is sued, is in the mean Time, by Commandment, employed in the King's Service, so that he cannot come at the Day assigned; this Writ is directed to the Justices, to the End that they may neither take, nor record him in Default for that Day.

WARRANTY, is a Promise or Covenant by Deed made by the Bargainer, for himself and his Heirs, to warrant or secure the Bargainee and his Heirs, against all Men, for the enjoying any thing agreed on between them; and this *Warranty* passeth from the Seller to the Buyer, from the Feoffer to the Feoffee, from him that releaseth, to him that is released from an Action real, and such like. *Warranty*, is either *real* or *personal*: *Real*, when it is annexed to Lands or Tenements granted for Life, &c. And this is either in *Deed*, or in *Law*: *Personal*, which either respects the Property of the Thing sold, or the Quality of it. *Real Warranty*, in respect of the Estate, is either *Lineal*, *Collateral*, or *commencing by Disseisin*; of which *Littleton* gives an Account in the last Chapter of his Tenure.

WARRECTUM and *Warrecta Terra*, is Land long neglected and uncultivated; for in old Records you will find, that *Tempus Warrecti* signifies the Time that Land lies fallow. *Warrectare* also signifies to fallow Land.

WARREN, is a Franchise, or Place privileged, either by Prescription or Grant from the Crown, to keep *Beasts and Fowl of Warren*; which are Hares and Conies, Partridges and Pheasants: And if any Person be found an Offender in any such *Free* or *Fee-Warren*, he is punishable for the same at Common-Law; and by the Statute *21 Edw. 3.* a *Fee-Warren* may lie open, and there is no necessity of closing that in, as there is of a Park; for that ought to be seized into the King's Hand, if it be not enclosed.

WASSEL-BOWL, was a large Cup or Bowl of Silver or Wood, wherein the Saxons at their publick Entertainments drank a Health to one another, in the Phrase *Was-heal* (*i. e.*) *Health be to you*. This *Wassel-Bowl* seems plainly to be meant by the Word *Vastellum*, in the Lives of the Abbots of *St. Alban's*, by *M. Paris*, p. 144. where he saith, *Abbas solus prandeat supremus in Refectorio habens*



*Wastellum*; that is, the Abbot had set by him at the upper-end of the Table, the *Wastell*, or *Wastell-Bowl*, to drink a Health to the Fraternity, or the *Poculum Charitatis*. So Cakes and White-Bread (which were commonly fopped in this Bowl) are called *Wastell-Bread*. And hence the Custom of going a *Wasselling*, as 'tis still called and used in *Suffex*, and some other Places, seems to have taken its Name.

**WASTE-Boards**, are Boards sometime set upon the Sides of a Boat, to keep the Sea from breaking into her.

**WASTE-Cloths**, are Cloths hung up on the uppermost Work of a Ship's Hull, to shadow the Men from an Enemy in the *Fight*; and therefore by some they are called *Fights*.

**WASTE-trees**, are those Timbers of a Ship which lie in the Waste.

**WASTE, of a Ship**, is that Part of her between the two Masts, *i. e.* between the *Main-mast* and the *Fore-mast*.

**WASTE, in Law**, hath divers Significations.

First, It is a Spoil, made either in Houses, Woods, Lands, &c. by the Tenant for Life, or Years, to the Prejudice of the Heir, or of him in Reversion or Remainder; whereupon the *Writ of Waste* is brought for the Recovery of the Thing wasted, and treble Damages.

*Waste of the Forest*, is most properly where a Man cuts down his own Woods within the Forest, without Licence of the King, or Lord-Chief-Justice in *Eyre*.

Secondly, *Waste* is taken for those Lands, which are not in any Man's Occupation, but lie common; which seem to be so called, because the Lord cannot make such Profit of them, as of his other Lands, by reason of that Use which others have of it, in passing to and fro: Upon this none may build, cut down Trees, dig, &c. without the Lord's Licence.

**WATCH, at Sea**, signifies the Space of 4 Hours, because half the Company or Crew watch and do Duty in their Turns, so long at a Time. All a Ship's Company is divided into two Parts, the *Larboard* and the *Starboard* Watch. The *Master* of the Ship Commands the latter, and the *Chief Mate* the former. Sometimes when a Ship is in Harbour, they watch but a *Quarter-watch*, as they call it; that is, but a Quarter of the Company watch at a time; because they have then but little to do, or look after.

**WATCH-Glafs**, being four Hours, is used at Sea, to shift or change their Watches. There are also *Half-watches*, *Hour-glasses*, *Minute*, and *half Minute-glasses*; by which last they count the Knots when they heave the Log, in order to find the Ship's Way.

**WATCH-work**, is the internal Parts of any Movement or Watch, which is designed to shew the Hour, or any other Division of Time without Striking; for whatever is contrived to produce that Effect, is called *Clock-work*; and that Part of the Movement is called the *Striking-part*.

The general Rules for the Calculation of *Watch-work*, are reducible to these Heads.

1. 'Tis certain that the same Motion may be performed either with one Wheel and one Pinion, or by many Wheels and many Pinions, provided that the Number of Turns of all those Wheels bear the

Proportion to all those Pinions, which that one Wheel bears to its Pinion; on (which is the same thing) that the Number produced by multiplying all the Wheels together, be to the Number produced by multiplying all the Pinions together, as that one Wheel is to that one Pinion.

Thus, suppose you had Use for a Wheel of 1440 Teeth, with a Pinion of 28 Leaves, you may make it into three Wheels and Pinions, *viz.*

$$4) 36, 7) 8, 1) 5.$$

For if the three Wheels 36, 8 and 5, be multiplied together, 'twill give 1440 for the Wheels; and if the 3 Pinions 4, 7 and 1, be also multiplied together, you'll have 28 for the Pinions.

It matters not in what Order the Wheels and Pinions are set, or which Pinion runs in which Wheel; only, for Contrivance sake, the biggest Numbers are commonly set to drive the rest.

2. Two Wheels and Pinions of different Numbers may perform the same Motion. As a Wheel of 36 drives a Pinion of 4, all one as a Wheel of 45 drives a Pinion of 5; or a Wheel of 90 drives a Pinion of 10. The Turns of each are 9.

3. If in breaking your Train into Parcels, any of your Quotients should not please you; or if you would alter any other two Numbers which are to be multiplied together, you may vary them by this Rule. Divide your two Numbers by any two other Numbers which will measure them; then multiply the Quotients by the alternate Divisors; the Product of these two last Numbers found, shall be equal to the Product of the two Numbers first given.

Thus, if you would vary 36 times 8, divide these by any two Numbers that will evenly measure them; as 36 by 4, it gives 9; and 8 by 1, it gives 8; now (by the Rule) 9 times 1 is 9, and 8 times 4 is 32: (See the Operation.)

$$\begin{array}{r} 9 \quad 8 \\ 36 \times 8 \\ 4 \quad 1 \\ \hline 32 \times 9 \end{array}$$

So that for  $36 \times 8$ , you have  $32 \times 9$ , which is equal to it, and each equal to 288.

And if you Divide 36 by 6, and 8 by 2, then multiply, as before is said, you'll have  $24 \times 12 = 36 \times 8 = 288$ .

$$\begin{array}{r} 6 \quad 4 \\ 36 \times 8 \\ 6 \quad 2 \\ \hline 24 \times 12 \end{array}$$

4. If it happens that you have a Wheel and Pinion fall out with cross Numbers, too big to be cut in Wheels, and yet not to be altered by the former Rules; then in seeking for your Pinion of Report, you may find out two Numbers of the same, or a near Proportion, by this Rule, *viz.* As either of the two given Numbers is to the other: So is 360 to a fourth. Divide that fourth Number, as also 360 by 4, 5, 6, 8, 9, 10, 12, 15 (each of



of which Numbers doth exactly measure 360) or by any one of those Numbers that bringeth a Quotient nearest to an Integer.

As suppose you had these two Numbers, 147 the Wheel, and 170 the Pinion, which are too great to be cut into small Wheels, and yet cannot be reduced into less, because they have no other common Measure, but Unity: Say therefore, As 170 : 147 :: 360 : 311. Or as 147 : 170 :: 360 : 416. Divide the 4th Number, and 360 by one of the foregoing Numbers; as 311 and 360 by 6, it gives 52 and 60: Divide them by 8, you will have 39 and 45. Also, if you Divide 360 and 416 by 8, you'll have 45 and 52 exactly. Wherefore instead of the two Numbers 147 and 170, you may take 52 and 60, or 39 and 45, or 45 and 52, &c.

5. When you come to Practice in calculating a Piece of *Watch-work*, the first Thing you are to do, is, to pitch upon your Train or Beats of the Balance in an Hour; as whether a swift Train of about 20000 Beats (which is the usual Train of a common 30 Hour Pocket-watch) or a slower Train of about 16000 (the Train of the new Pendulum Pocket-watches) or any other Train.

Having chosen your Train, then resolve upon the Number of Turns you intend your Fusy shall have, and upon the Number of Hours you would have your Piece to go: As suppose 12 Turns, and to go 30 Hours, or 192 Hours (*i. e.* eight Days,) &c.

Then proceed to find out the Beats of the Balance or Pendulum in one Turn of the Fusy, by the Direction given under the Word *Beat*; thus in Numbers, 12 : 16 :: 20000 : 26666. Wherefore, 26666 are the Beats in one Turn of the Fusy or great Wheel, and are equal to the Quotients of all the Wheels unto the Balance multiplied together: But now this Number is to be broken into a convenient Parcel of Quotients; which is to be done thus:

First, halve your Number of Beats, *viz.* 26666, and you'll have 13333; then pitch upon the Number of your Crown-wheel, as suppose 17. Divide 13333 by 17, and you'll have 784 for the Quotients (or Turns) of the rest of the Wheels and Pinions; which being too big for one or two Quotients, may be best broken into three: Chuse therefore three Numbers, which when multiplied all together continually, will come nearest 784. As suppose 10, 9 and 9, multiplied continually, gives 810, which is somewhat too much; therefore try again other Numbers, 11, 9 and 8; these drawn one into another continually, produce 792, which is as near as can be, and convenient Quotients.

Having thus contrived your Piece from the great Wheel to the Balance; but the Numbers not falling out exactly, according as you at first proposed, you must correct your Work thus:

First (by the Direction given under the Word *Beats*) multiply 792 (the Product of all the Quotients pitched upon) by 17, the Notches of the Crown-wheel, the Product is 13464, which is half the Number of Beats in one Turn of the Fusy; then (by a Rule given under the Word *Beat*) find the true Number of Beats in an Hour.

Thus, 16 : 12 :: 13464 : 10098, which is half the Beats in an Hour.

Then find what Quotient is to be laid upon the *Pinion of Report* (by the Rule given under that Word.)

Thus, 16 : 12 :: 12 : 9, the Quotient of the *Pinion of Report*.

Now having found your Quotients, 'tis easy to determine what Numbers your Pinions shall have; for chuse what Numbers your Wheels shall have, and multiply the Pinion by their Quotients, and that produceth the Number for your Wheels, as you see in the Margin.

|             |
|-------------|
| 4 ) 36 ( 9  |
| 5 ) 55 ( 11 |
| 5 ) 45 ( 9  |
| 5 ) 40 ( 8  |
| 17          |

Thus the Number of your *Pinion of Report* is 4, and its Quotient 9; therefore the Number for the Dial-Wheel must be  $4 \times 9$  or 36; so the next Pinion being 5, its Quotient 11, therefore the great Wheel must be  $5 \times 11 = 55$ , and so of the rest.

Thus you have the common and practical Method of calculating the Numbers of a 16 Hour Watch.

And this Watch may be made to go a longer Time by lessening the Train, and altering the Pinion of Report.

As suppose you could conveniently slacken the Train to 16000; then by the Rule given under the Word *Beat*, say, As  $\frac{1}{2}$  16000, or 8000 : 13464 :: 12 : 20. So that this Watch will go 20 Hours.

Then for the Pinion of Report, say, (by the Rule given under that Word) As 20 : 12 :: 12 : 7. So that 7 is the Quotient of the Pinion of Report.

And as to the Numbers, the Operation is the same as before, only the Dial-wheel is but 28, for its Quotient is altered to 7.

|             |
|-------------|
| 4 ) 28 ( 7  |
| 5 ) 55 ( 11 |
| 5 ) 45 ( 9  |
| 5 ) 48 ( 8  |
| 17          |

But if you would give Numbers to a Watch of about 10000 Beats in an Hour, to have 12 Turns of the Fusy, to go 170 Hours, and 17 Notches in the Crown-wheel.

The Work is the same in a manner, as in the last Example, and consequently thus:

As 12 : 170 :: 10000 : 141666; which fourth Number are the Beats in one Turn of the Fusy; Its half 70833 being divided by 17, gives 4167 for the Quotients. And because this Number is too big for three Quotients, therefore chuse four, as 10, 8, 8,  $6\frac{2}{3}$ , whose Product into 17 maketh 71803, nearly equal to half the true Beats in one Turn of the Fusy.

Then say, as 170 : 12 :: 71808 : 5067, which is half the true Train of your Watch.

And say again, 170 : 12 :: 12 :  $\frac{144}{170}$ , (or 170) 144, which expresses the Pinion of Report, and the Number of the Dial-wheel.

But these Numbers being too big to be cut in small Wheels, therefore they must be varied by the fourth Rule of this, saying,

As 144 : 170 :: 360 : 425.  
Or 170 : 144 :: 360 : 305.

Then dividinng 360, and either of these two fourth Proportionals (as directed by the Rule) suppose by 15, you'll have  $\frac{24}{5}$  or  $\frac{20}{3}$ ; then the Numbers of the whole Movement will stand thus:

Thus



$$\begin{array}{r}
 24 \overline{) 20} \left( \frac{20}{24} \right. \\
 \hline
 6 \overline{) 60} \left( 10 \right. \\
 6 \overline{) 48} \left( 8 \right. \\
 5 \overline{) 40} \left( 8 \right. \\
 5 \overline{) 33} \left( 6\frac{3}{5} \right. \\
 \hline
 \hline
 \end{array}$$

17

Thus much may serve concerning the Calculation of ordinary Watches, to shew the Hour of the Day: But in such as shew Minutes and Seconds, the Process is thus:

First, having resolved upon your Beats in an Hour, then by dividing your designed Train by 60, find the Beats in a Minute; and accordingly, find out such proper Numbers for your Crown-wheel and Quotients, as that the Minute-wheel shall go round once in an Hour, and the Second-wheel once a Minute.

As suppose you should chuse a Pendulum of six Inches to go 8 Days, with 16 Turns of the Fusy; a Pendulum of six Inches (by Mr. Smith's Tables in *Moral. Disq.*) vibrates 9368 in an Hour; and consequently, dividing it by 60, gives 156, the Beats in a Minute. Half these Sums are 4684 and 78. Now the first Work is to break this 78 into good Proportion; which will fall into one Quotient, and the Crown-wheel. Let the Crown-wheel have 15 Notches; then 78 divided by 15, gives 5; so

8) 40 (5 a Crown-wheel of 15, and a Wheel and Pinion, whose Quotient is 5, will go round in a Minute, to carry a Hand to shew *Seconds*. Next for a Hand to go round in an Hour, to shew Minutes. And because there are 60 Minutes in an Hour, 'tis but breaking 60 into good Quotients (as suppose 8) 60 (7½ 10 and 6, or 8 and 7, or &c.) and 'tis done.

15 Thus 4684 is broken, as near as can be, into proper Numbers.

But since it don't fall out exactly into the above-mentioned Numbers, you must correct (as you were directed before) and find out the true Number of Beats in an Hour, by multiplying 15 by 5, which makes 75; and 75 by 60, makes 4500, which is the half of the true Train. Then find the Beats in one Turn of the Fusy, thus, 16 : 192 :: 4500 : 54000; which last are half the Beats in one Turn of the Fusy. This 54000 being divided by 4500 (which are the true Numbers already pitched upon) the Quotient will be 12, which being not too big for one single Quotient, needs not be divided into more, and the Work will stand thus:

As to the Hour-hand, the great Wheel which performs only one Revolution in 12 Turns of the Minute-wheel, will shew the Hour; or you may order it to be done by the Minute-wheel.

15

For the Calculation of the Striking Part of any Clock, observe these Directions:

1. Consider that here you need have regard only to the *Count-wheel*, *Striking-wheel*, and *Detent-*

*wheel*, which move round in this Proportion.

The *Count-wheel* commonly goes round once in 12 or 24 Hours: The *Detent-wheel* moves round every Stroke the Clock striketh, or sometimes but once in two Strokes; wherefore it follows, That,

2. As many Pins as are in the Pin-wheel, so many Turns hath the Detent-wheel in one Turn of the Pin-wheel; or (which is the same) the Pins of the Pin-wheel are the Quotient of that Wheel, divided by the Pinion of the Detent-wheel. But if the Detent-wheel moveth but once round in two Strokes of the Clock, then the said Quotient is but half the Number of Pins.

3. As many Turns of the Pin-wheel as are required to perform the Strokes of 12 Hours (which are 78) so many Turns must the Pinion of Report have to turn round the Count-wheel once: Or thus, the Quotient of 78 divided by the Number of Striking-pins, shall be the Quotient for the Pinion of Report, and the Count-wheel; and this is in case the Pinion of Report be fixed to the Arbor of the Pin-wheel, as is commonly done. This Example will make all plain: The Locking-wheel being 8) 48 ( 6 48, the Pinion of Report 8, the 6) 78 ( 13 Pin-wheel 78, the Striking-pins are 6) 60 ( 10 13, and so of the rest. Note also, 6) 48 ( 8 That 78 divided by 13, gives 6, the Quotient of the Pinion of Report.

As for the *Warning-wheel* and *Flying-wheel*, it matters little what Numbers they have, their Use being only to bridle the Rapidity of the Motion of the other Wheels.

4. The following Rules will also be of great Use in this kind of Calculation; and by their Helps these Problems may readily be resolved.

1. To find how many Strokes the Clock striketh in one Turn of the Fusy and Barrel.

As the Number of Turns of the Great-wheel, or Fusy: Is to the Days of the Clock's Continuance :: So is the Number of Strokes in 24 Hours, viz. 156: To the Strokes in one Turn of the Fusy or Great-wheel.

2. To find how many Days the Clock will go.

As the Number of Strokes in 24 Hours, viz. 156: Is to the Strokes in one Turn of the Fusy :: So is the Turns of the Fusy or Great-wheel: To the Days of the Clock's Continuance or Going.

3. To find the Number of Turns of the Fusy or Barrel.

As the Strokes in one Turn of the Fusy: Is to the Strokes in 24 Hours, viz. 156 :: So is the Clock's Continuance: To the Number of Turns of the Fusy or Great-wheel.

4. To fit the Pinion of Report on the Spindle of the Great-wheel.

As the Number of Strokes in the Clock's Continuance, or in all its Turns of the Fusy: To the Turns



Turns of the Fusy :: So are the Strokes in 12 Hours, which are 78 : To the Quotient of the Pinion of Report, fixed upon the Arbor of the Great-wheel.

5. *To fix the Pinion of Report to any Wheel.*

Divide 78 by the Number of Strokes in one Turn of the Wheel you intend to fix your Pinion of Report upon, and your Quotient shall be that of the Pinion of Report.

6. *To find the Strokes in the Clock's Continuance, viz.*

As 12 : Is to 78 :: So are the Hours of the Clock's Continuance : To the Number of Strokes in that Time.

Or thus rather ; Multiply the Strokes in one Turn of the Great-wheel by the Number of Turns of the Fusy, the Product are the Strokes in the Clock's Continuance.

The Use of these Rules appear plain by the following Examples.

1. In small Pieces ; having pitched upon the Number of Turns, and the Continuance of your Clock, find (by Rule 6.) the Strokes in its Continuance ; then (if you make the Great-wheel the Pinion-wheel) divide these Strokes by the Number of Turns, and you have the Number of Striking-pins ; or divide by the Number of Pins, and you have the Number of Turns.

Thus a Clock of 30 Hours, with 15 Turns of the Great-wheel, hath 195 Strokes.

For (by Rule 6.)  $12 : 78 :: 30 : 195$ .

Dividing by 15  $\{ 195 \div 15 = 13$ , the Striking-pin.  
by 13  $\{ 195 \div 13 = 15$ , the Number of Turns.

2. In Calculating the Numbers of a Clock of much longer Continuance, you must make your Pin-wheel further distant from the Great-wheel : And having pitched upon your Turns, find out the Number of Strokes in one Turn of the Great-wheel or Fusy (by Rule 1.) Thus in an 8 Day Piece of 16 Turns, As  $16 : 8 :: 156 : 78$ . Also, in a Piece of 32 Days and 16 Turns,  $16 : 32 :: 156 : 312$ .

These Strokes thus found, are the Number which is to be broken into a convenient Parcel of Quotients, thus :

First, resolve upon the Number of your Striking-pins, by which divide the last mentioned Number, the Quotient arising shall be one or more Quotients for the Wheels and Pinions. Thus in the Month-piece, if you take your Pins 8, divide 312 by it, the Quotient is 39 ; but that being too big for one, must be cut into two Quotients for Wheels and Pinions, or as near as possible, which are either 7 and 5, or 6 and 6, which last is equal to 39, and therefore may stand, and will be thus :

10) 65 (6½  
8) 48 (6  
6) 48 (8 Pins.

The Quotient being thus determined, and accordingly the Wheels and Pinions ; then find a Quotient for the Pinion of Report, to carry round the Count-wheel once in 12 Hours, or as you please. If you fix your Pinion of Report on the Great-wheel Arbor, you must work by the fourth Rule.

Thus in the last Example, the Strokes in the Continuance are 4992 (by Rule 6.) then (by Rule 4.) as  $4992 : 16 :: 78 : 1248$ , or  $4992 : 1248$ , which is the Pinion and the Wheel.

But these Numbers being not the usual Numbers of a Month-piece, but only made use of here for Illustration sake ; and in Practice they commonly increase the Number of Strikings, and so make the Second-wheel the Striking-wheel. Suppose you take 24 Pins, divide 312 by it, and the Quotient is 13, which is little enough for one Quotient, and may therefore stand thus :

8) 104 (13  
6) 72 (12, 24 Pins ;

Where the Quotient of the First-wheel is 13. In the Second-wheel of 72 Teeth, are the 24 Pins, altho' its Quotient is but 12, because the Hoop-wheel is double, and goes round but once in two Strokes of the Pin-wheel. In this the Pinion of Report is the same with the last, if fixed upon the Arbor of the Great-wheel. But if fixed on the Arbor of the Second or Pin-wheel, its Quotient is found by Rule 5, viz. 78 divided by 24, gives the Quotient of the Pinion of Report  $3\frac{1}{4}$ , thus 12) 39 ( $3\frac{1}{4}$  The Pinion of Report being then 12, the Count-wheel will be 39.

The Calculation of a Year-piece is the same ; however, to perfect the Reader therein, we shall give this Example.

Suppose your Piece was to go 395 Days with 16 Turns, and 26 Striking-pins. There are 3851 Strokes in one Turn of the Great-wheel (by the Rule 1.) for  $16 : 395 :: 156 : 3851$ . And 3851 divided by 26, leaves 148 to be broken into Quotients, for Wheels and Pinions, which may be 12 and 12 ; for 12 into 12, gives 144, which is as near as it can well be to 148 ; then the Work stands thus :

10) 120 (12  
8) 96 (12  
) 78 (26 Pins.

In this Place it would not be amiss for you to correct your Work, and see how near your Number comes to what you designed at first, because they did not fall out exact.

First, for the true Continuance of your Clock, Multiply the Quotients and Striking-pins together, and you'll have the true Number of Strokes in one Turn of the Great-wheel. So here,  $12 \times 12 \times 26 = 3744$ , which is the true Number of Strokes ; then the true Continuance (by Rule 2.) is 384, for

As  $156 : 3744 :: 16 : 384$ .

If this Continuance doth not please you, you may come nearer to your first proposed Number of 395 Days by a small Encrease of the Number



of Turns (by Rule 3.) viz. making your Turns almost  $16\frac{1}{2}$ ; for,

As  $3744 : 156 :: 395 : 16\frac{1}{2}$  near.

But for the Pinion of Report, if you fix it on the Great-wheel, it will require an excessive Number; if you fix it upon the Pin-wheel, which is usual, then (by Rule 5.) it will stand thus, 13) 393) the Quotient is 3, the Pinion of Report 13, and the Count-wheel 39.

If to any Clock it be required to fit *Quarters* or *Chimes*, &c. you may proceed thus.

1. You are to consider, that *Quarters* are generally a distinct Part from the Clock-part, which striketh the Hour; and the *Striking-wheel* may be the First, Second-wheel, &c. according to your Clock's Continuance; unto which Wheel you may fix the Pinion of Report.

The *Locking-wheel* must be divided into 4, 8, or more unequal Parts, so as to strike the Quarter, and lock at the first Notch, or the half Hour, and lock at the second Notch, &c. And in doing this you may make it to chime the Quarters, or strike them upon two Bells, or more.

'Tis usual for the Pin-wheel or the Locking-wheel to unlock the Hour-part in these Clocks; which is easily done by some Jogg or Latch, at the End of the last Quarter, to lift up the Detents of the Hour-parts.

If you would have your Clock strike at the half Hour, as well as whole Hour, you must make the Locking-wheel of the Hour-part double; that is, it must have two Notches of a sort, to strike 1, 2, 3, 4, &c. twice a-piece.

2. As for *Chimes*, I need say nothing of the Lifting-pieces and Detents, to lock and unlock; nor of the Wheels to bridle the Motion of the Barrel; only you are to observe, that the Barrel must be as long in turning round, as you are in fingering the Tune it is to Play.

As for the *Chime-Barrel*, it may be made up of certain Bars that run a-thwart it, with a convenient Number of Holes punched in them, to put in the Pins that are to draw each Hammer. By this means you may change the Tune, without changing the Barrel. Such is the *Royal Exchange Clock* in *London*, and others. In this Case, the Pins or Nut which draw the Hammers, must hang down from the Bar, some more, some less, and some standing upright in the Bar; the Reason whereof is, to play the Time of the Tune rightly.

For the Distance of each of these Bars may be a Semibrief, &c. of which hereafter.

But the usual way is, to have the Pins that draw the Hammers fixed on the Barrel. For the placing of which Pins, you may proceed by the way of Changes on Bells, viz. 1, 2, 3, 4, &c. Or rather make use of the Musical Notes.

Where you must observe, what is the Compass of your Tune, or how many Notes or Bells there are from the highest to the lowest; and accordingly, the Barrel must be divided from End to End.

Thus, in the following Examples, each of those Tunes are 8 Notes in compass; and accordingly,

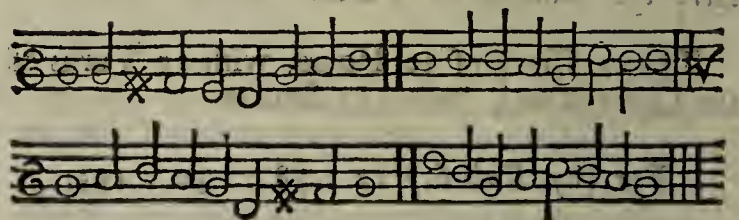
the Barrel is divided into 8 Parts. These Divisions are struck round the Barrel, opposite to which are the Hammer-tails.

I speak here, as if there was only one Hammer to each Bell, that you may more clearly apprehend what I am explaining. But when two Notes of the same Sound come together in a Tune, there must be two Hammers to that Bell to strike it. So that, if in all the Tunes you intend to chime, of 8 Notes compass, there should happen to be such double Notes on every Bell, instead of 8 you must have 16 Hammers; and accordingly, you must divide your Barrel, and strike 16 Strokes round it, opposite to each Hammer-tail.

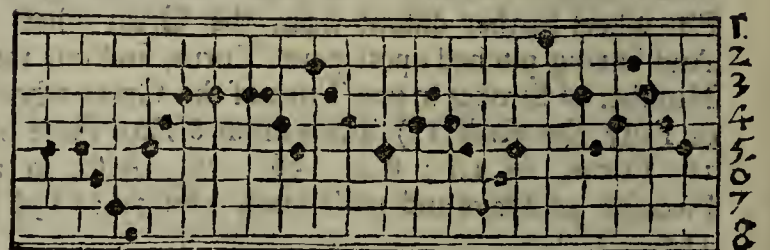
Then you are to divide it round about into as many Divisions, as there are Musical Bars, Semibriefs, Minims, &c. in your Tune.

Thus the 100 Psalm-tune hath 20 Semibriefs; and each Division of it is a Semibrief. The first Note of it also is a Semibrief, and therefore on the Chime-Barrel must be a whole Division from 5 to 5, as you may understand plainly, if you conceive the Surface of a Chime-Barrel to be presented by the following Tables, as if the Cylindrical Superficies of the Barrel were stretched out at length or extended on a Plane. And then such a Table so dotted or divided, if it were to be wrapped round the Barrel, would shew the Places where all the Pins are to stand in the Barrel: For the Dots running about the Table, are the Places of the Pins that play the Tune.

The Notes of the 100 Psalm.



A Table for Dividing the Chime-Barrel of the 100 Psalm.



If you would have your Chimes compleat indeed, you ought to have a Set of Bells to the Gamut Notes; so as that each Bell having the true Sound of *Sol, La, Mi, Fa*, you may play any Tune with its Flats and Sharps; nay, you may by these means play both the Bass and Treble with one Barrel.

And by setting the Names of your Bells at the Head of any Tune, you may easily transfer that Tune to your Chime-Barrel, without any Skill in Musick. But observe, that each Line in the Musick is three Notes distant; that is, there is a Note between each Line, as well as upon it,



*To Calculate a Piece of Clock-work that shall represent any of the Celestial Motions.*

To effect which, you may either make those Motions to depend on the Work already in the Movement, or else you may measure them by the Beats of a Balance or Pendulum.

If you would proceed the latter way, you must however contrive a Piece to go a certain Time, with a certain Number of Turns.

But to determine the Motion intended, you must proceed one of these two ways; either,

1. Find how many Beats are in the Revolution; divide these Beats by the Beats in one Turn of the Wheel or Pinion, which you intend shall drive the intended Revolution, and the Quotient shall be the Number to perform the same; which, if it be too big for one, may be broken into more Quotients. Thus, if you would represent the Synodical Revolution of the Moon (which is 29 Days,  $12\frac{1}{4}$  Hours) with a Pendulum that swings Seconds, the Movement to go 8 Days, with 16 Turns of the Fusy, and the Great-wheel to drive the Revolution, divide 2551500 (the Beats in 29 Days,  $12\frac{1}{4}$  Hours) by 4200 (the Beats in one Turn of the Great-wheel) and you'll have 59 in the Quotient; which being too big for one, may be put into the Quotients.

Or,

2. You may proceed as directed before in Calculating a Piece of Watch-work, *viz.* Choose your Train, Turns of the Fusy, Continuance, &c. And then, instead of finding a Quotient for the Pinion of Report, find a Number (which is all one as a Pinion of Report) to Specificate your Revolution by this Rule following.

As the Beats in one Turn of the Great-wheel : Is to the Train :: So are the Hours of the Revolution : To the Quotient of the Revolution.

Thus, to perform the Revolution of *Saturn* (which in 29 Years, 183 Days) with a 16 Hour Watch, of 26928 Beats in one Turn of the Fusy, and 20196 the Train; the Quotient of the Revolution will be 193824. For as 26928 : 20196 :: 258432 : (the Hours in 22 Years and 183 Days) To 193824.

Here Note, That the Great-wheel Pinion is to drive the Revolution-work.

But if you would have the Revolution to be driven by the Dial-wheel, and the Work already in the Movement, then you must first know the Days of the Revolution. And because the Dial-wheel commonly goeth round twice in a Day, therefore double the Number of the Days in the Revolution, and you have the Number of Turns of the Dial-wheel in that Time. This Number of Turns, is what you are to break into a convenient Number of Quotients, for the Wheels and Pinions.

#### 1. *A Motion to shew the Day of the Month.*

The Days in the largest Month are 31; those doubled are 62, which are the Turns of the Dial-

wheel, which may be broken into these two Quotients  $15\frac{1}{2}$  and 4, whose Product is 62; therefore choosing your Wheels and Pinions (by the former Directions) your Work is done, and will stand thus:

$$\begin{array}{r} 4) 62 (15\frac{1}{2} \\ 5) 20 (4 \end{array}$$

Or if a larger Pinion than one of 5 be necessary, by reason it is concentrick to a Wheel, you may take 10 for the Pinion, and 40 for the Wheel; then 'twill stand thus:

$$\begin{array}{r} 4) 62 (15 \\ 10) 40 (4 \end{array}$$

And the Work will lie thus in the Movement, *viz.* Fix your Pinion 10 concentrical to the Dial-wheel (or to turn round with it upon the same Spindle.) This Pinion 10 drives the Wheel 40; which Wheel has the Pinion 4 in its Centre, which carrieth about a Ring of 62 Teeth, divided on the upper Side into 31 Parts or Days.

Or, without the Trouble of many Wheels you may effect this Motion, *viz.* By a Ring divided into 30 or 31 Days, and as many Fangs or Teeth, which are caught and pushed forward once in 24 Hours by a Pin in the Wheel, that goeth round in that Time. This is the usual way in Royal Pendulums, and many other Watches; and therefore being common, there needs no more be said of it.

#### 2. *A Motion to shew the Age of the Moon.*

The Moon finisheth her Course in 29 Days and a little above an half. This  $29\frac{1}{2}$  Days (not regarding the small Excess) makes 59 twelve Hours or Turns of the Dial-wheel, which is to be broken into convenient Quotients; which may be 5, 9, and 10, as here.

$$\begin{array}{r} 10) 59 (59 \\ 4) 49 (10) 10) 40 (4 \end{array}$$

Or  $14\frac{1}{2}$  and 4; so that if you fix a Pinion of 10 concentrical with your Dial-wheel, to drive a Wheel of 40, which drives a Pinion of 4, which carries about a Ring or Wheel of 59 Teeth once in  $29\frac{1}{2}$  Days; which Ring may be also divided into  $29\frac{1}{2}$  Parts; or carry an Index to point to a Circle so divided.

#### 3. *A Motion to shew the Day of the Year, the Sun's Place in the Ecliptick, Sun's Rising or Setting, or any other Annual Motion of 365 Days.*

The Double of 365, is 730, the Turns of the Dial-wheel in one Year; which may be broken into these Quotients, *viz.*  $18\frac{1}{2}$  and 10 and 4, thus,

$$\begin{array}{r} 4) 73 (18\frac{1}{2} \\ 4) 40 (10 \\ 5) 20 (4 \end{array}$$



Or into  $18\frac{1}{4}$ , 8 and 5 thus,

$$\begin{array}{r} 4) 73 \text{ ( } 18\frac{1}{4} \\ 4) 32 \text{ ( } 8 \\ 3) 20 \text{ ( } 5 \end{array}$$

So that a Pinion of 5 is to lead a Wheel of 20, which again, by a Pinion of 40; and that by a Pinion of 4, carrieth about a Wheel or Ring of 73 divided into 12 Months, and their Days; or into the 12 Signs, and their Degrees, or into the Sun's Rising and Setting, &c. And for the Setting on of this last, Mr. Oughtred has given a Table in his *Opuscula*.

#### 4. To shew the Tides at any Port.

This is done without any other Trouble, than the Moon's Ring (mentioned in the 2 of this) to move round by a fixed Circle, divided into twice 12 Hours, and numbred the contrary way to the Age of the Moon.

To set this to go right, you must find out at what Point of the Compass the Moon makes Full Sea at the Place you would have your Watch serve to: Convert that Point into Hours, allowing for every Point North or South, lost 45 of an Hour.

Thus at *London-Bridge*, 'tis vulgarly thought to be High-water the Moon at North East and South-west, which are four Points from the North or South.

Or thus: By the Tide-Tables, learn how many Hours from the Moon's Southing, 'tis High-water.

Or thus: Find at what Hour it is High-water, at the Full and Change of the Moon; as at *London-Bridge*, the Full Tide is reckoned to be three Hours from the Moon's Southing, or at 3 of the Clock at the Full and Change. The Day of Conjunction, or *New-Moon*, with a little Stud to point, being set to the Hour so found, will afterwards point to the Hour of the full Tide.

This is the common way: But this Ring being always in Motion, whereas the Tides are not, a better way perhaps may be found out; as suppose by causing a Wheel or Ring to be moved forward only twice a Day, and to keep Time (as near as can be) with the accurate Mr. Flamsteed's most correct Tables.

#### 5. To calculate Numbers, to shew the Motion of the Planets, the slow Motion of the fixed Stars, the Sun's Apogæum, the Revolution of the Dragon's Head and Tail, whereby the Eclipses of the Sun and Moon are found, the Revolution of the several Orbs, according to the Ptolemaick System, or of the Celestial Bodies themselves, according to better Systems, &c.

Besides the Direction already given, there needs only thus much in general, *i. e.* Knowing the Years of any of these Revolutions, you may break that Number into Quotients, if you will make the Revolution depend upon the Year's Motion which is already in the Movement, and described in the 3d of this. Or if you would have it depend upon the Dial-wheel, or upon the Beats of a Pendulum, enough is said before to direct you in this Matter.

In all these slow Motions, you may somewhat shorten your Labour by endless Screws to serve for Pinions, which are but as a Pinion of one Tooth.

An Instance of this you have in the Account Sir *Jonas Moore* gives of his large Sphere-going Clock-work, in his *Math. Compendium*, p. 117. where a Motion of 17100 Years is performed by six Wheels, being for the Sun's *Apogæum*. His Words are these.

"For the Great-wheel fixed is 96, a Spindle-wheel of 12 Bars turns round it 8 times in 24 Hours; that is, in 3 Hours; after these, there are four Wheels, 20, 73, 24, 75, wrought by endless Screws that are in Value but one; wherefore 3, 20, 73, 24, and 75, multiplied together continually produceth 7884000 Hours, which divided by 24, gives 3285000 Days, equal to 900 Years. Now on the last Wheel, 75 is a Pinion of 6, turning a great Wheel that carrieth the *Apogæum* Number 114; and 114 divided by 6, gives 19 the Quotient; and 900 Times 19, is 17100 Years."

**WATER.** Sir *Is. Newton* defines Water (when pure) to be a very fluid Salt, volatile, and void of all Sapor or Taste, and it seems to consist of small, smooth, hard, porous, spherical Particles, of equal Diameters, and of equal specifick Gravities, as Dr. *Cheyne* observes; and also that there are between them Spaces so large, and ranged in such a manner, as to be pervious on all Sides. Their *Smoothness* accounts for their sliding easily over one another's Surfaces; their *Sphericity* keeps them also from touching one another in more Points than one; and by both these, their *Frictions* in sliding over one another, are rendered the least possible. Their *Hardness* accounts for the *Incompressibility* of Water, when 'tis free from Intermixture of Air.

The *Porosity* of Water is so very great, that there is at least 40 times as much Space as Matter in it; for Water is 19 Times specifically lighter than Gold, and consequently *rarer* in the same Proportion; but Gold will, by Pressure, let Water pass through its Pores, and therefore may be supposed to have (at least) more Pores than solid Parts. Now 'tis this great Porosity of Water that accounts for its different specifick Gravity, in comparison of *Mercury* or other Fluids; and also why 'tis more easily concreted into a solid Form, by adventitious Matter in Freezing, than other Fluids are.

Dr. *Cheyne* observes rightly, that the Quantity of Water on this side our Globe doth daily decrease, some Part thereof being every Day turn'd into *Animal*, *Vegetable*, *Metalline*, or *Mineral* Substances; which are not easily dissolved again into their component Parts; for separate a few Particles of any Fluid, and fasten them to a solid Body, or keep them asunder one from another, and they are no more fluid; for, to produce *Fluidity*, a considerable number of such Particles is required. (See *Fluidity*) Most of the Liquors we know are formed by the Cohesion of Particles of different Figures, Magnitudes, Gravities, and *attractive* Powers (See *Attraction* and *Particles*) swimming in pure Water, or an aqueous Fluid; which seems to be the common Basis of all. And the only Reason why there are so many sorts of Water differing from one another by different Properties, certainly is, here the Corpuscles of *Salts* and *Minerals*, with which that Element is impregnated, are equally various. *Wine* is only Water impregnated with Particles of Grapes, and



and Beer with Particles of Barley. All *Spirits* seem to be nothing but *Water*, saturated with *saline* or sulphureous Particles. And all Liquors are more or less fluid, according to the *greater* or *smaller* Cohesion of the Particles which swim in the aqueous Fluid; and there is hardly any Fluid without this Cohesion of Particles, not even *pure Water* itself; as is apparent from the Bubbles which sometimes will stand on its Surface, as well as on that of *Spirits*, and other Liquors.

*WATER-Bailiff*, was an Officer in Port-Towns, appointed for the searching of Ships, as seems from 28 H. 6. c. 5. Now there is such an Officer in the City of *London*, who supervises and searches all Fish brought thither; and he gathers the Toll arising from the River of *Thames*. He also attends on the Lord-Mayor, and hath the principal Care of marshalling the Guests at the Table. And he arrests Men for Debt, or other personal or criminal Matters, on the River of *Thames*, by Warrant of his Superiors, &c.

*WATER-Measure*, is a Measure mention'd in the 22 Stat. of Car. 2. and exceeds the *Winchester* Measure by about 3 Gallons in a Bushel. 'Tis now used for selling of Coals in the Pool, &c.

*WATER-Ordeal*, was one of the old *Saxon* Ways of Purgation, or Trial of a Person's Innocence, when suspected of a Crime; 'twas called *Judicium Dei*, as the *Fire-Ordeal* was. This by Water, was, for the Person accused either to put his Hands into scalding Water, or to be thrown into some River, Pond, &c. if he escaped being burnt or scalded, or of being drowned, he was concluded innocent. This Water-Ordeal was for Churls, Bondmen, and other Rusticks: But the Fire-Ordeal was for Freemen, and Persons of better Condition.

*WATER-Table*, in Architecture, is a sort of Ledge left in Stone or Brick-Walls, about 18 or 20 Inches from the Ground, and there the Thickness of the Wall begins to abate.

*WATER*, which the Chymists call *Phlegm*, is the 4th of the 5 Chymical Principles, and one of the Passive ones. 'Tis never drawn pure and unmix'd, which makes it a little more deterfive than common Water.

This Principle, probably, contributes much to the Growth of Bodies, in that it both renders and keeps the active Principles fluid. So that they are capable of being convey'd by Circulation into the Pores of the Mix'd; and also, because it tempers their exorbitant Motion, and keeps them together, so that they are not so easily and soon dissipated.

In all such Bodies, whose active Substances are joined and united pretty closely together, as in common Salt, Tartar, all Plants that are not odoriferous, and in many Animal Bodies this Principle is the first that comes in Distillation. But when Water is mixed with volatile Salts, or with the Spirit of Wine, or is in any odoriferous Mixts, then the volatile Particles will rise and come away first.

*WATER-Borne*, is when a Ship, even and just with the Ground, first begins to float or swim, being borne up by the Water.

*WATER-Line* of a Ship, is that which distinguisheth that Part of her which is under Water from that above, when she is duly laden.

*WATER-Shot*, is a sort of Riding at Anchor, when a Ship is *Moored* neither cross the Tide nor right up and down, but quartered betwixt both.

*WATER-Way*, in a Ship, is a small Piece of Timber lying fore and aft on her Deck, close by her Sides, to prevent the Water's running down there.

*WATERY Humour* of the Eye: See *Aqueous Humours*.

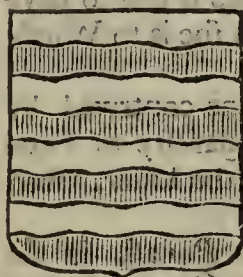
*WATERY Meteors*: See *Meteors*.

*WATLING-Street*, is the Name of one of the four Roman Ways, by that Nation made here in *England*, and by them were called *Consulares*, *Prætorias*, *Militares*, & *Publicas*. In the Laws of *Edw. the Confessor*, it appears that these Publick Ways had the Privilege of the King's Peace. This of *Watling-street*, or otherwise *Werlam-street*, (see *Hoveden part. prior. Annal. Fol. 248.*) was made from *Dover* to *London*, thence to *St. Albans*, *Dunstable*, *Towcester*, *Atherston*, and the *Severn*, near the *Wrekin* in *Shropshire*, extending it self to *Anglesey* in *Wales*. Anno 39 Eliz. c. 2.

The second of these Ways is called *Ikemild-street* (ab *Icenis*) and reached from *Southampton* over the River *Isis*, at *Newbridge*; thence by *Camden* and *Litchfield*, and so over the *Derwent* by *Derby*, thence to *Bolseover-Castle*, and ends at *Tinmouth*.

The third was called the *Fosse*, because in some Places it was never finished, but lies as a large Ditch, leading from *Cornwall* thro' *Devonshire*, by *Tetbury*, near *Stow* in the *Wold*, and besides *Coventry* to *Leicester*, *Newark*, and so to *Lincoln*.

The fourth was called *Ermine*, or *Erminage-street*, beginning at *St. David's* in *Wales*, and going to *Southampton*. See *Hollingshed's Chron. Vol. 1. c. 19.* and *Henry of Huntingdon, Book 1.* at the Beginning.



*WAVY*, in Heraldry, signifies representing the Waves rolling, which the *French* call *Ondée*, and the *Latins*, *undulatus*, *undatus*, &c. See the Escutcheon.

*WAVES of the Sea*, or any Water. Sir *Isaac Newton* has demonstrated, *Lib. 2. Prop. 45. Princip.* That their Velocity is always in half the Ratio of their Breadth; and their Breadth is estimated to be the Distance between the two Summits, or top Edges of any two Waves; or a right Line drawn from the middle of one Hollow to the middle of the other.

Let there be a Pendulum, whose Length from the Point of Suspension to the Centre of Oscillation shall be the Breadth of any two Waves; then while the Pendulum makes its Oscillations, the Waves will pass over a Distance equal to their Breadth.

Hence he concludes, That those Waves whose Latitude or Breadth is  $3\frac{1}{8}$  Parisian Feet, will pass over a Distance equal to their Breadth in a Second of Time.

And in the Time of one Minute, these Waves will run 183  $\frac{1}{3}$  Feet, and in the Space of an Hour 11000 such Feet nearly.

*WAVESON*, is the Term for such Goods as, after Shipwreck, do appear swimming on the Waves.



**WAY** of a Ship, is sometimes the same with the *Rake* or *Run* of her forward or aftward on: But 'tis mostly used as to her Sailing: For when she goes a-pace, they say, *she hath a good Way*, or makes a fresh Way. Also, when they keep an Account how fast she sails by the Log, they call it *keeping an Account of her Way*: And because most Ships are apt to *fall a little to Leeward* of their true Course, they always in casting up the Log-board, allow something for her *Leeward Way*, or *Lee-way*; which is one Point or more according to her Way of Sailing.

**WAY of the Rounds**, in Fortification, is a Space left for the Passage of the *Rounds* between the Rampart and the Wall of a Fortified Town. But it is not so much in use, because not having a Parapet above a Foot thick, it may be soon overthrown by the Enemies Cannon.

**WAYWISER**, the same with Perambulator; which see.

**WEALD**, or *Weld*, is a Saxon Word, signifying the woody part of a Country: As the *Weald* of *Suffex*, and of *Kent*, in the Collect. of Statutes, 14 Car. II. c. 6. 'Tis mis-printed, as 'tis vulgarly pronounced, *the Wild* of *Suffex*, &c.

**WEAPON-SALVE**: See *Armarium*.

**WEAR**, a Term used by the Seamen for bringing a Ship to, on a different Tack.

**WEATHER-Board**, *Sea Term*, that side of a Ship that is to the Windward.

**WEATHERING**, in *Sea Language*, a doubling or getting to the Windward of a Point or Place.

**WEATHER-COYLE**; when a Ship being a Hull, has her Head brought about, so as to lie that way which her Stern did before, without loosing of any Sail, but only by the bearing up of the Helm, this is called *Weather-coyling* of her.

**WEATHER-GAGE**, that Ship is said to have the *Weather-gage* of another, when she is to Windward of her.

**WEIGHING-Chair**, a Machine contrived by *Sanctorius*, for determining the Quantity of Food taken at a Meal, and to admonish the Eater, when he had eaten his *Quantum*.

**WEIGHING an Anchor**, *Sea Phrase*, is the drawing up the Anchor out of the Ground it had been cast into; in order to set sail or quit a Port, Road or the like.

**WEED**, in the Miners Language, is the Degeneracy of a *Load* or *Vein* of fine Metal, into an useless *Marchasite*.

**WEDGE**. See *Cuneus*.

**WEIGH** of Cheese, Wool, &c. *Waga*, alias *Vaga*, is 256 Pound Weight *Averdupois*; for by 9 Hen. VI. c. 8. a Weigh of Cheese ought to contain 32 Cloves, and each Clove 8 Pound; though some say but 7.

**WEIGHT**, in *Physicks*, Gravity, a Quality in natural Bodies, by which they tend downwards towards the Centre of the Earth, or in a more general Sense, a Power inherent in all Bodies, by which they tend to some common Point, called the Centre of *Weight* or *Gravity*, and that with a greater or less Velocity, as they are more or less dense, or as the Medium they pass through is more or less rare.

**WEIGHT**, in *Mechanicks*, is any thing which is to be raised, sustained or moved by a Machine or any other thing that in any manner resists the Motion to be produced in all Machines; there is

a natural *Ratio* between the Weight and the moving Power. If the Weight be increased the Power must be so too; that is, the *Wheels*, &c. are to be multiplied, and by that means the Time increased, or the Velocity diminished.

**WEIGHT of the Air**: See Air. Mr. *Boyle* calculates, that when the Mercury in the common Barometer stands at 30 Inches, the Weight of the whole Atmospherical Column of Air, incumbent on an Inch Square of Space, is 18 Pounds  $\frac{1}{2}$  Troy, or 15 Pounds  $\frac{1}{7}$  *Averdupois*.

**WEIGHTS**, in use in *England*, are chiefly of two sorts: One called *Troy-weight*, having 12 Ounces in the Pound; and by this, Jewels, Silver, Gold, Corn, Bread, and all Liquors are usually weighed; and the other is called *Averdupois*, containing 16 Ounces in the Pound; by this all coarse, drossy wastable Wares, such as Grocery, Pitch, Tar, Rosin, Wax, Tallow, Copper, Tin, Lead, Iron, &c. are weighed.

*Georg. Agricola*, in his Book *de Ponderibus & Mensuris*, calls the Pound of twelve Ounces, or the Pound Troy, *Libram Medicam*, which we retain in our Apothecaries Weight (see the Table of it under *Weights*), and the other Pound of 16 Ounces, he calls *Libram Civilem*: and he saith also, that *Medica & Civilis Libra Numero non Gravitate Unciarum differunt*.

The Original of all our *English* Weights was a Corn of Wheat, gathered out of the middle of the Ear; and being well dried, 32 of these made one Penny-weight, or were the Weight of the *Penny-Sterling*; twenty of these Pence or Penny-weights, were to make an Ounce, and twelve such Ounces made the Pound Troy. See 51 Hen. III. 31 Edw. I. and 12 Hen. VII.

But in latter Times it was thought sufficient to divide the aforesaid Penny-weight into 24 equal Parts, which came to be called *Grains*, being the smallest Weight now in common Use; tho' the Moneyers subdivide the Grain thus:

|            |        |           |
|------------|--------|-----------|
| 24 Blanks  | } make | 1 Periot. |
| 20 Periot. |        | 1 Droite, |
| 24 Droits  |        | 1 Mite.   |
| 20 Mites   |        | 1 Grain.  |

#### WEIGHT of a Cubick-Inch of several Bodies.

Mr. *Boyle* found that the Weight of a Cubick-Inch

Of Water was 356 Grains.

Of Quicksilver 3580 Grains.

|                | Weight. | Magnitudo. | Weight in Water |
|----------------|---------|------------|-----------------|
|                | Oz.     |            |                 |
| Gold.          | 9.91735 | 0.10083    | 9.33962         |
| Quicksilver.   | 7.93388 | 0.12604    | 7.35615         |
| Lead.          | 6.16198 | 0.16229    | 5.58425         |
| Silver.        | 5.50083 | 0.18179    | 4.92310         |
| Copper.        | 4.81342 | 0.20776    | 4.23569         |
| Hammered Iron. | 4.27715 | 0.23380    | 3.69942         |
| Cast Iron.     | 3.96321 | 0.25258    | 3.29048         |
| Tin.           | 3.96694 | 0.25208    | 3.38921         |
| Marble.        | 1.59631 | 0.62644    | 1.01858         |
| Common Stones. | 1.09835 | 0.91045    | 0.52062         |
| Honey.         | 0.79339 | 1.26042    | 0.21566         |
| Salt Water.    | 0.57773 | 1.79490    |                 |
| Fresh Water.   | 0.527 3 | 1.77490    |                 |
| Oil.           | 0.47603 | 2.10069    |                 |
| Wheat.         | 0.37628 | 2.65757    |                 |
| Dried Oak.     | 0.40745 | 2.45609    |                 |



The Weight of Bodies on the Surface of the Planets.

|                                |        |                          |
|--------------------------------|--------|--------------------------|
| Suppose in the Sun<br>it weigh | 10000  | that same Body<br>on the |
| Earth must weigh               | 01251½ |                          |
| Of { Jupiter,                  | 00804½ |                          |
| { Moon,                        | 00630  |                          |
| { Saturn,                      | 00536  |                          |

Weight of a Cubick Foot of several Bodies.

| Averdupois Weight.      | lb. | oz. |   |
|-------------------------|-----|-----|---|
| Wheat of the best sort, | 48  | 8   | 0 |
| White Oats,             | 29  | 8   | 0 |
| White Pease,            | 50  | 8   | 0 |
| Barley,                 | 41  | 2   | 0 |
| Malt two Months old,    | 30  | 4   | 0 |
| Field Beans,            | 50  | 8   | 0 |
| Wheaten-meal unsifted,  | 31  | 0   | 0 |
| Rye-meal unsifted,      | 28  | 0   | 0 |
| Pump-water,             | 62  | 8   | 0 |
| Bay-salt,               | 54  | 1   | 0 |
| White Sea-salt,         | 43  | 12  | 0 |
| Common Sand,            | 85  | 4   | 0 |
| Newcastle Coal,         | 67  | 12  | 0 |
| Gravel,                 | 109 | 5   | 0 |
| Wood-ashes,             | 58  | 5   | 0 |

Our Excellent Sir *Isaac Newton* saith, he found, by most accurate Experiments on Pendulums, that the Quantity of Matter in Bodies, is always proportionable to their *Weight*.

He saith also, That the *Attractiones Motrices*, or Weights of one Sphere, or Globe, to another at equal Distances from the Centers, are as the attracting and attracted Sphere multiplied into one another; or as the Product of those two Spheres. But at unequal Distances from the Centers, as those Products divided by the Squares of the Distances between the Centers, *Prop. 76. Corol. Lib. 1.*

A Table of the Foreign Pound Averdupois, compared with our Pound English.

|              | The Pound Averdupois into 100 Parts. |
|--------------|--------------------------------------|
| London,      | 100                                  |
| Paris,       | 0.93                                 |
| Lyon,        | 1.09                                 |
| Bologn,      | 0.89                                 |
| Amsterdam,   | 0.93                                 |
| Antwerp,     | 0.98                                 |
| Leyden,      | 0.96                                 |
| Lorain,      | 0.98                                 |
| Mechlin,     | 0.98                                 |
| Middlebourg, | 0.98                                 |
| Strasbourg,  | 0.93                                 |
| Bremen,      | 0.94                                 |
| Cologn,      | 0.97                                 |
| Frankfort,   | 0.93                                 |
| Hamborough,  | 0.95                                 |
| Leipsick,    | 1.15                                 |
| Norimberg,   | 0.94                                 |
| Vienna,      | 0.83                                 |
| Castile,     | 0.99                                 |
| Lisbon,      | 1.06                                 |
| Gibraltar,   | 1.03                                 |
| Toledo,      | 1.00                                 |

|                 |      |
|-----------------|------|
| Rome,           | 1.23 |
| Bononia,        | 1.27 |
| Florence,       | 1.23 |
| Naples,         | 1.43 |
| Genoa,          | 1.42 |
| Mantua,         | 1.43 |
| Milan,          | 1.40 |
| Parma,          | 1.43 |
| Venice,         | 1.53 |
| Dantzick,       | 1.19 |
| Copenhagen,     | 0.94 |
| Prague,         | 1.06 |
| Cairo,          | 1.61 |
| Constantinople, | 0.86 |

*Averdupois Weight*, is that by which all Physical Drugs, Grocery, Rosin, Wax, Pitch, Tar, Tallow, Soap, Hemp, and all things that have Waste; all base Metals and Minerals, as Iron, Steel, Lead, Tin, Copper, Alom, Coperas, &c. are weighed.

A Table of Averdupois Weight.

| Scruple. | Drachms. | Ounces. | Pounds. | Hundreds. | Tuns. |
|----------|----------|---------|---------|-----------|-------|
| 3        |          |         |         |           |       |
| 24       | 8        |         |         |           |       |
| 384      | 128      | 16      |         |           |       |
| 43008    | 14336    | 1792    | 112     |           |       |
| 860160   | 28720    | 35840   | 2240    | 20        |       |

*Troy Weight*, is that by which Gold, Silver, Jewels, Amber, Electuaries, Bread, Corn, Liquors, &c. are weighed; and from this Weight all Measures of wet and dry Commodities are taken.

A Table of Troy Weight.

| Grains. | Penny-weight. | Ounces. | Pounds. |
|---------|---------------|---------|---------|
| 24      |               |         |         |
| 488     | 20            |         |         |
| 5760    | 240           | 12      |         |

A Table of Apothecaries Weight.

| Grains. | Scruples. | Drachms. | Ounces. | Pounds. |
|---------|-----------|----------|---------|---------|
| 20      |           |          |         |         |
| 60      | 3         |          |         |         |
| 480     | 24        | 8        |         |         |
| 5700    | 288       | 96       | 12      |         |

Foreign Weight.

Generally three sorts of *Weights* are used for Merchandize.

1. Weights of great Content; as Hundreds, Kintals, Centeners, Talents, Thousands, Weighs, Skippounds, Charges, Lisponds, Rooves, &c.
2. Weights



2. Weights of lesser Content; as Pounds, Mina's, Manehs, Rotuli, &c.

3. Small Weights; as Ounces of 12, 14, 16, 18, 20, 30, &c. to the Pound, and the Subdivisions of the Ounce.

Talents of the *Hebrews, Greeks*, are seen before.

Cantars, Centeners, or Kintals, sometimes wrote Quintals, accounted by Merchants as Hundreds; are of 100, 112, 120, 125, 128, 132, and 140 Pounds.

Weights, or Weys, are commonly 165 Pound, or 180 Pound, or 200 Pound and  $\frac{1}{2}$  for a Charge. Skippounds, used in many Places, *quasi Shippound*, or *Skippond*; for as in *Italy*, and other Countries, the *Carga, Cargo*, or *Charge*, is the Loading of an Horse of 300 or 400 Pound: So is the Skippound taken for the Dividend of a Last of Corn laden in a Ship. Skippounds are of 300, 320, 340, and

400 Pound to the Skippound. *Cargo* is often taken for the whole Lading or Burthen of a Ship.

Lispounds, of 15, 16, and sometimes 20 Pound to the Lispound.

Rooves, or Arrobas, of 10, 20, 25, 30, and 40 Pound to the Roove.

Stone of 6, 8, 14, 16, 18, 20, 21, 24, 32, and 40 Pound to some Stones.

Poade of *Russia*, by *Heylin* is 40 Pounds.

Mixias, is commonly understood to be 10000 Drachms, of 8 to an Ounce, and 12 Ounces to a Pound.

Sestertia's of *Cleopatra* in *Egypt*, and other Places in *Africa*, were two Pounds  $\frac{1}{2}$ , for 50 Sestertia's make 125 Pound, but in *Thracia* it was but  $2\frac{1}{6}$  of a Pound.

Pound is divided into more or less Ounces.

Mark Weight, commonly 8 Ounces.

Mark Pound 16 Ounces, that is 2 Marks.

*Mina Ptolemaica*,  $1\frac{1}{2}$  Rotuli, or 18 Ounces, or 144 Drachms, and in lesser Divisions thus:

|       | Rotuli.        | Ounces. | Drachms. | Scruple. | Oboli.  | Lupines.       | Siliqua's,<br>or<br>Carrats. | Aereoli.       |
|-------|----------------|---------|----------|----------|---------|----------------|------------------------------|----------------|
| Mina. | $1\frac{1}{2}$ | 18      | 144      | 432      | 864     | 1296           | 2592                         | 6912           |
|       | Rotulus        | 12      | 96       | 288      | 576     | 864            | 1728                         | 4608           |
|       |                | Ounce.  | 8        | 24       | 48      | 72             | 144                          | 384            |
|       |                |         | Drachm.  | 3        | 6       | 9              | 18                           | 48             |
|       |                |         |          | Scruple. | 2       | 3              | 6                            | 16             |
|       |                |         |          |          | Obolus. | $1\frac{1}{2}$ | 3                            | 8              |
|       |                |         |          |          |         | Lupine.        | 2                            | $5\frac{1}{3}$ |
|       |                |         |          |          |         |                | Siliqua,<br>or<br>Carrat.    | $2\frac{1}{2}$ |

Mane, or Manch, in *Arabia*, double one of 16 Ounces, and one of 20 Ounces.

That called *Alialica, Basaria, Alanthalica*, and *Ægyptia*.

This *Romana*, and is indeed of *Alexandria*, the Pound there being 20 Ounces.

Rotulus in *Arabia, Syria, Asia Minor, Ægypt*, and *Venice*, reckoned for a Pound, is thus divided.

|                   | Sachosi,<br>or<br>Ounces.          | Sextaries,<br>or<br>Cicles. | Deniers,<br>or<br>Aureos.                              | Darching,<br>or<br>Drachms.                                 | Scruples,<br>or<br>Garma. | Obolos,<br>or<br>Orloffs.          | Danings,<br>or<br>Lupines.          | Kirats,<br>or<br>Siliqua's. | Aereolas,<br>or<br>Kestuffs. |
|-------------------|------------------------------------|-----------------------------|--|---|---------------------------|------------------------------------|-------------------------------------|-----------------------------|------------------------------|
| Rotulus or Pound. | 12                                 | 24                          | 84   | 96  | 288                       | 576                                | 864                                 | 1728                        | 3456                         |
|                   | Sachos,<br>Sachos,<br>or<br>Ounce. | 2                           | 7  | 8   | 24                        | 48                                 | 72                                  | 144                         | 288                          |
|                   |                                    | Sextary,<br>of<br>Cicle.    | $3\frac{1}{2}$   | 4   | 12                        | 24                                 | 36                                  | 72                          | 144                          |
|                   |                                    |                             | Denier,<br>or<br>Aureus,<br>Aunius,<br>Auda-<br>nakus. | $1\frac{1}{7}$  | $3\frac{6}{7}$            | $6\frac{6}{7}$                     | $10\frac{2}{7}$                     | $20\frac{4}{7}$             | $41\frac{1}{7}$              |
|                   |                                    |                             | Drachm,<br>or<br>Darch-<br>ing Alky,<br>Oliginat.      | 3   | 6                         | 9                                  | 18                                  | 36                          | 12                           |
|                   |                                    |                             |  | Scruple,<br>or<br>Garme,<br>or<br>Obolus,<br>Kenmer Orloff, | 2                         | 3                                  | 6                                   | 12                          | 24                           |
|                   |                                    |                             |  |   | Onolaffat<br>Onalum.      | Danings,<br>or<br>Danic<br>Lupine. | 2                                   | 4                           | 8                            |
|                   |                                    |                             |  |   |                           |                                    | Carrat,<br>Kirat,<br>or<br>Siliqua. | 2                           | 4                            |



Some mention the Phyfick Pound at *Venice* to have but 7 Drachms. in the Ounce.

The Lupines at *Venice*, called *Sextula's*, because 1 Ounce, hath 72, which is 6 times 12.

Every Kestuff, or Aereolum (or Areolum) is the Weight of 2 Barly-Corns, so is there in the Rotulus 6912 Grains.

The *Alexandrian* Pound 20 Ounces, the Ounce 8 Scruples.

The *Italian* Pound generally is divided into 12 Ounces, 1 Ounce into 2 Staters, and 1 Stater into 4 Drachms; so hath 1 Pound 24 Staters, 96 Drachms.

But in Phyfick; there and in other Places, thus.

|        | Ounces. | Loots. | Sizaynes,<br>or<br>Siliquas.     | Drams. | Scruples. | Obolos. | Siliquas. | Grains. |
|--------|---------|--------|----------------------------------|--------|-----------|---------|-----------|---------|
| Pound. | 12      | 24     | 48                               | 96     | 288       | 576     | 1728      | 5760    |
| Ounce. |         | 2      | 4                                | 8      | 24        | 48      | 144       | 480     |
|        |         | Loot.  | 2                                | 4      | 12        | 24      | 72        | 240     |
|        |         |        | Sizayne,<br>or<br>Siliqua. Dram. | 2      | 6         | 12      | 36        | 120     |
|        |         |        |                                  |        | 3         | 6       | 18        | 60      |
|        |         |        |                                  |        | Scruple.  | 2       | 6         | 20      |
|        |         |        |                                  |        |           | Obolus. | 3         | 10      |
|        |         |        |                                  |        |           |         | Siliqua.  | 3½      |

*Spain*, some say, hath a *Mina Romana*, which contains 20 Ounces: A common Pound of 16 Ounces, and a Phyfick Pound of 12 Ounces, each

Ounce divided into 8 Drachms. The Ounce of the *Toletan* Phyfick Pound excepted, which hath, as some affirm, 9 Scruples.

|                   | Libra. | 3. | Duels. | Quar-<br>terns. | Sixths. | 3.  | Syrian<br>Beans. | €   | Obolos. | Carats. | Chalcos. | Grains. |
|-------------------|--------|----|--------|-----------------|---------|-----|------------------|-----|---------|---------|----------|---------|
| Mina Ro-<br>mana. | 1½     | 20 | 60     | 80              | 120     | 160 | 240              | 480 | 960     | 2880    | 5760     | 11520   |
|                   | Libra. | 12 | 36     | 48              | 72      | 96  | 144              | 288 | 576     | 1728    | 3456     | 6912    |
|                   |        | 3. | 3.     | 4               | 6       | 8   | 12               | 24  | 48      | 144     | 288      | 576     |
|                   |        |    | Duels. | 1½              | 2       | 2½  | 4                | 8   | 16      | 48      | 96       | 192     |
|                   |        |    |        | Quar-<br>terns. | 1½      | 2   | 3                | 6   | 12      | 36      | 72       | 144     |
|                   |        |    |        |                 | Sixths. | 1½  | 2                | 4   | 8       | 24      | 48       | 96      |
|                   |        |    |        |                 |         | 3.  | 1½               | 3   | 6       | 18      | 36       | 72      |
|                   |        |    |        |                 |         |     | Syrian<br>Bean.  | 2   | 4       | 12      | 24       | 48      |
|                   |        |    |        |                 |         |     |                  | Θ   | 2       | 6       | 12       | 24      |
|                   |        |    |        |                 |         |     |                  |     | Obolos. | 3       | 6        | 12      |
|                   |        |    |        |                 |         |     |                  |     |         | Carat.  | 2        | 4       |
|                   |        |    |        |                 |         |     |                  |     |         |         | Chalcus  | 2       |



The common Pound of Spain.

|        | Marks. | Ounces. | Drams. | Adarmes,<br>or<br>Adarams. |
|--------|--------|---------|--------|----------------------------|
| Pound. | 2      | 16      | 218    | 256                        |
|        | Mark.  | 8       | 64     | 128                        |
|        |        | Ounce.  | 8      | 16                         |
|        |        |         | Dram.  | 2                          |

The Physick Pound of Lyons.

|        | Ounces. | Drams. | Scruples. | Grains. |
|--------|---------|--------|-----------|---------|
| Pound. | 12      | 96     | 288       | 5760    |
|        | Ounce.  | 8      | 24        | 480     |
|        |         | Dram.  | 3         | 60      |
|        |         |        | Scruple.  | 20      |

Cotgrave mentions a Weight called *Sentule*, of 4 Scruples, or the sixth Part of 1 Ounce.

The Physick Pound of Toledo.

|        | Ounces. | Drams. | Scruples. | Grains. |
|--------|---------|--------|-----------|---------|
| Pound. | 12      | 108    | 324       | 6480    |
|        | Ounce.  | 9      | 27        | 540     |
|        |         | Dram.  | 3         | 60      |
|        |         |        | Scruples. | 20      |

Pound Weights of Germany.

The Pound Weight of Vienna in Austria.

|        | Ounces. | Loots. | Quints. | Pennin. | Grains. |
|--------|---------|--------|---------|---------|---------|
| Pound. | 16      | 32     | 128     | 512     |         |
|        | Ounce.  | 2      | 8       | 32      |         |
|        |         | Loots. | 4       | 16      |         |
|        |         |        | Quints. | 4       |         |
|        |         |        |         | Penn.   | 25      |

Pound Weights of France.

The Weight used by the Merchants for the most part, is of 16 Ounces, called *Livre d' Anvers*, tho' in some Places but 14, others 18 Ounces. Cotgrave writes the *Liure*, or *Bund de Lyon*, to be 15 Ounces, that *de Spaigne* but 14 Ounces, and divides the Pound of 16 Ounces into 30 Halfs, 64 Sezaines, 128 Treseaun, 256 Grofs, 512 Demi-grofs. And the Pound used by the *Farriers*, consisting of 12 Ounces, into 90 Drams, 270 Scruples, 540 Obolcs.

After *Malines*, the Ordinary, or Pound commonly used for Merchants, is parted thus.

The Pound Weight of Paris.

|        | Ounces. | Grofs. | Scruples. | Grains. |
|--------|---------|--------|-----------|---------|
| Pound. | 16      | 128    | 384       | 9216    |
|        | Ounce.  | 8      | 24        | 576     |
|        |         | Grofs. | 3         | 72      |
|        |         |        | Scruple.  | 24      |

The German Physick Pound, by Alsted.

|        | Ounces. | Drams. | Scruples. | Grains. |
|--------|---------|--------|-----------|---------|
| Pound. | 12      | 96     | 288       | 5760    |
|        | Ounce.  | 8      | 24        | 480     |
|        |         | Dram.  | 3         | 60      |
|        |         |        | Scruple.  | 20      |

In the *Low-Countries* they use Pounds of 12, 14, 15, &c. Ounces.

At *Bruges* in *Flanders*, they have 1 Pound of 14 Ounces, and 1 Pound of 16 Ounces; the 100 Pound of 16 Ounces makes 108 Pound of 14 Ounces; but the Ounces of 14 to the Pound are the heaviest, for 100 of these are 105  $\frac{1}{2}$  Ounces of 6 to the Pound: This Pound is thus divided.

Pound.



|        | Ounces.  | Loots. | Sizaines. | Drams. |
|--------|----------|--------|-----------|--------|
| Pound. | 16       | 32     | 64        | 128    |
| Ounce. | 2        | 4      | 8         |        |
|        | Loot.    | 2      | 4         |        |
|        | Sizaine. | 2      |           |        |

Drachm or Quint.

At *Antwerp* they use to weigh by the Hundred Pounds even Weight, called *Suttle*, for which commonly at the Weigh-house is allow'd 101 Pound. A Stone is 8 Pound. The Skippound 300 Pound. The Weigh 165 Pound. The Carga, or Charge, 400 Pound, which is two Bales of 203 Pound each, for an Horse to carry. The Pound there is 16 Ounces.

This 100 Pound of Antwerp, weigheth in the Places following.

- 1 3 *Abbeville*, 94 $\frac{1}{2}$  lb.
- 2 11 *Achri*, 171 Rotuli. The 100, a Cantar Tambaran.
- Alaer, { 138 Ordinary Weight.  
91 To weigh Steel, Tin, and Copper.
- 1 8 *Ailost*, 108 lb.
- 3 1 *Alcario*, { 164 lb.  
78 Minas of 16 Oz. to the Mina.  
or *Cario*, { 27 Rotuli, of 6 lb. to the Rotuli.  
1 Peso is 1 $\frac{1}{2}$  Metallicum, or a Drachm.  
50 Metallici 1 Mark. Our Mark 42 Metallici.  
Musk and Amber sold by this Weight in *Egypt*.
- 2 11 *Aleppo*, 22 Rotuli, of 100 to a Cantar.  
1 Rotulus is 60 Oz. or 480 Metecalos, or Drachms.  
1 Oz. is 8 Metecalos, or Drachms.  
1 Drachm, or Metecalo, is  $\frac{1}{2}$  Pesa.  
10 Pesa's are 1 Onga, or Ongia, to weigh Civet.
- 2 1 *Alexandria*, { 108 Rotuli of 190 to a Cantar.  
78 Mina's of 20 Oz.
- America Ma-* { 90 lb. of 12 Oz. to the lb.  
*lica*, { 36 Mina's Sestertias of 30 Oz.
- 2 11 *Aman*, as *Aleppo*.
- 1 8 *Amsterdam*, 94 $\frac{3}{4}$  lb. And for Silks they use the Weight of *Antwerp*.
- 1 7 *Aquila*, 147 lb.
- 1 3 *Aquismort*, 102 lb.
- 2 2 *Ara-* { 78 Rotuli.  
*bia*, { 144 Maires, or Minas.  
148 Pound.  
936 Ounces, or Sachosi, 12 to 1 Rotulus.
- 3 1 *Arcadia*, 92 lb. and 83 lb. for *Mavigetto*.
- 1 5 *Archipelago*, 120 lb.
- Armaria bo-* { 105 lb. of Oz. to the lb.  
*na*, { 93 lb. of 18 Oz. used for Silk and Copper.  
54 lb. of 32 Oz. Flesh Weight.
- 2 3 *Armenia*, 130 lb.

- 1 14 *Arra-* { 106 lb.  
*gon*, { 96 lb. Great Weight for Wool.
- 1 8 *Arshot*, 100 lb. all one with *Antwerp*.
- 1 8 *Audenarde*, or *Oudenard*, 110 lb.
- 1 3 *Avignon*, 111 lb. a Centener is two Frailes of 56 lb.
- 1 4 *Ausburgh*, 95 lb.
- 1 8 *Bergen Op Zome*, 98 lb.
- 1 14 *Barce-* { 96 lb. Wooll Weight.  
*lona*, { 106 lb. Common Weight.  
131 lb. Saffron Weight.
- 1 4 *Basil*, 96 lb. They use Centeners of 100 lb. 120 lb. and 132 lb.
- 1 7 *Bergamo*, 137 lb. and 108 lb. by the two Quintals.
- 1 1 *Bergen*, 96 lb. but uncertain weighing with a Sling.
- 1 4 *Bibrach*, 92 lb. of 16 Oz. to 1 lb. as *Constance*.
- 2 11 *Barutti*, 21 Rotuli.
- 1 7 *Bologna*, 53 lb. of 30 Oz. to weigh Wax and Wooll by Rooves of 1 lb.
- 1 4 *Burgoigne*, as *Abbeville*.
- 1 4 *Botfen*, { 128 lb. Ordinary Weight.  
91 lb. To weigh Steel, Tin, and Copper.
- 1 3 *Bourdeaux*, as *Abbeville*.
- 1 4 *Bres-* { 120 lb. by the Centener of 24 lb.  
*lau*, { to one Stone, and five Stone  
to one Centener, and 5 $\frac{1}{2}$  Stone  
to the Centener of 132 lb. there  
also used.
- 1 7 *Brescia*, 184 lb. and for *Venice* Gold 136 lb. 100 lb.  
93 lb. for Butter and Cheese, the Stone 6 lb. and 20 Stone one Weigh; but Wooll Weight is 108 lb. weighed by Stones of 6 lb. called Nails, or Neils, 18 Neils to the Hundred, 45 Neils to the Weigh, 2 Weighs to one Pocket of Wooll. *Hunt* says, 18 Neils is 144 lb. of our Wooll Weight.
- 1 8 *Brussels*, as *Arshot*.
- Bucca*, 44 Ocha's.
- 1 14 *Burgos*, 93 Rotuli.
- 2 1 *Bursa*, 88 Rotuli.
- 3 4 *Cabo Verde*, 170 $\frac{1}{2}$  lb. or Rotuli; a Quintal is 121 of 4 Rooves of 32 lb.
- 1 7 *Calabria*, 147 lb.
- 1 3 *Calais*, { 111 lb. Ordinary Weight.  
92 lb. Merchants Weight.  
114 lb *Engl'sh* Wooll Weight.
- 2 6 *Calicut*, 80 Aracoles. *Malines*, p. 18, mentioning the Baccar, or Bahar, at *Calicut*, to be at *Lisbon* 4 great Quintals of 112 lb. to the Quintal, and that 4 Quintals are 480 Aracoles, that is 120 Aracoles for 1 Quintal: And again, that the Bahar is 20 Faracoles, which is 5 Quintals at *Lisbon* of 32 lb. per Roove; which is not well to be understood, seeing the great Quintal at *Lisbon* is 128 lb. or 4 Rooves of 32 lb. per Roove: Whereas 4 Quintals of 112 lb. is but 448 lb. and 5 Quintals of 728 lb. is 640 lb. unless there be two sorts of Bahars at *Calicut*, one of 48 Aracoles, and



- and another of 20 Faracoles. Or that the Bahar be 5 great Quintals at 129 lb. the Quintal; that is 645 lb. for so many Pounds; or *Portuguese* Rotuly, are in 480 Aracoles, for 100 lb. of *Antwerp*, which answer to 107½ lb. of *Portugal* Weight by his own Concession in the same Page a little before.
- 3 3 *Canary-Islands*, 107 lb. as *Sévil*.  
 1 5 *Candia*, { 138 lb. for Gold-Thread.  
                   { 89 Rotuli, whereof a 100 is a Cantar, or Quintal.
- 1 7 *Carpi*, as *Aquila*.  
 1 14 *Castile*, 102 lb.  
       *Cataio*, 87 Rotuli, 100 to a Cantar.
- 1 7 *Censena*, as *Bergamo*.  
 1 4 *Collen*, 93½ lb.  
 1 7 *Como*, as *Aquila*.  
 1 9 *Coningsberg*, 125 lb. which is a Centener. A Last of Wheat there 5200 lb. a Stone 40 lb. a Skippound 10 Stone, that is 400 lb.
- 1 4 *Constance*, 92 lb. of 16 Ounces, or 32 Loot: Some by the Centener of 100 lb. and some of 120 lb.
- 1 5 *Constantinople*, 87½ Rotuli, 100 to a Cantar. *Hunt* writes it *Cobaa*.  
 1 1 *Copenhagen*, 2½ Metallici, which is their Drachm, makes 3 of ours.
- 1 1 *Copenhagen*, 96 lb. There the Centener is 112 lb. A Stone is 10 lb. A Skippound 32 Stone, or 20 Lippound of 16 Markpound, which is a Skippound; or 320 lb.
- 1 5 *Corfu*, { 97 lb. Great Weight.  
                   { 115 lb. Small Weight.
- 1 8 *Cortrycke*, as *Audenarde*.  
 1 3 *Cracow*, 124 lb. The Centener there is 136 lb.
- 1 7 *Crema*, as *Aquila*.  
       { 143 lb. of 12 Oz. most used.  
       { 132 lb. of 12 Oz. being 13 Oz. of the other.  
       { 60 lb. of 28 Oz. to the lb. used for Fleth.
- 2 1 *Cyprus*, 20¼ Rotuli, 100 to the Cantar.
- 2 11 *Damascus*, 26 Rotuli. There 1 Cantar is 5 Zurli, or Stone; and 1 Stone 20 Rotuli; 1 Rivola is 225 lb. *Antwerp*.
- 1 9 *Dantzick*, 120 lb. There one Last of Wheat 4528 lb. The Last of Rye 4245 lb. 1 Skippound 340 lb. of 10 great Stone, 1 Skippound 320 lb. of 20 Lippound. 1 Centener 125 lb. 1 Stone for Spices 24 lb. 1 Great Stone for Gros-Wares 34 lb. 1 Lippound 16 Mark Pound.
- 1 3 *Diepe*, as *Abbeville*.  
 1 8 *Dixmude*, as *Ailost*.  
 1 8 *Doway*, as *Audenarde*.  
 1 6 *Dublin*, and in *Ireland* generally, { 91½ lb. by the Great Hundred.  
                                   { 104 lb. Subtle Weight.
- 1 12 *Edinbu.* { 96 lb. and 103 lb. ½ for 112 lb.  
 and all *Scot.* }
- 1 4 *Erfurd*, 85 lb. as at *Vienna*.  
 1 7 *Faenza*, 132 lb.
- 3 2 *Fez*, or *Fesse*, 96 lb. *Hunt* wrote *Feas*, and noted as in *Portugal*.  
 1 7 *Ferrara*, as *Bergamo*.  
       *Fio*, 96¼ Rotuli, or Scutarii.  
 1 7 *Fiume*, as *Venice*.  
 1 8 *Flanders*, 110 lb. for the most part.  
 1 7 *Florence*, 125 lb. of 12 Oz. to the lb.  
 3 1 *Forfori*, 65 Rotuli.  
 1 7 *Forli*, as *Aquila*.  
 1 3 *France*, generally 111 lb. except herein excepted.
- 1 4 *Frankfort*, { as *Basil*.  
 1 4 *Friburg*, }
- 1 8 *Ghent*, as *Ailost*.  
 1 8 *Guelderland*, 99 lb. The places herein excepted.
- 1 7 *Genes*, or *Genoa*, { by Rooves, to a Quintal of 4 Rooves, 4 lb. and over.  
                                   { 110 lb. a Quintal of Pepper.  
                                   { 114 lb. a Quintal of Ginger.  
                                   { 102 lb. Weight for Spice. A Carga is 270 lb. Small weight.  
                                   { 85 lb. Great weight.
- 1 7 *Geneva*, {
- 1 4 *Germany*, a Centener of the small Weights is 100 lb. of the great 120 lb. and 132 lb. The Centener of 120 lb. is 5 Stone, of 24 lb. per Stone.
- 2 6 *Goa*, as *Portugal*, by Quintals, Arrobes, or Rooves, &c. They have also another Weight, called *Mao*, which signifieth the Hand, and weigheth 12 lb. is used for Butter, Honey, Sugar, &c. in the *Portugal* Dominions.
- 1 14 *Granada*, as *Armaria bona*.  
 3 4 *Guinea*, as *Cabo Verde*.  
 1 1 *Hamburgh*, 96 lb. The Centener 120 lb. of 12 Stone, 1 Stone 10 lb. A Lippound 15 lb. and 20. Lippound 1 Skippound.
- 1 4 *Heidelburgh*, as *Basil*.  
 1 4 *Hertogenbosch*, as *Arshot*.  
 1 8 *Holland*, as *Guelderland*.  
 1 8 *Hulst*, as *Ailost*.  
 1 8 *Ypre*, as *Ailost*.  
 1 7 *Istria*, as *Venice*.  
 1 5 *Laarta* 87 Rotuli, 100 to a Cantar.
- 1 5 *Laconia*, { 138 lb.  
                   { 78½ Rotuli.
- 1 7 *Lansan*, as *Bergamo*.  
 1 5 *Lavalona*, 131 lb.  
 1 4 *Leon*, 109 lb.
- 1 5 *Lepanto*, { 156 lb.  
                   { 26 Rotuli, 1 Rotulus 6 lb.
- 1 4 *Leipsick*, as *Basil*.  
 1 10 *Lisbon*: See *Calicut*.  
 1 8 *Lisle*, as *Audenard*.
- 1 8 *London*, and all *England*, { 91½ lb. Gross Weight of the Kintal Weight 112 lb.  
                                   { 104 lb. Subtle Weight.  
                                   { 189½ Marks of 8 Oz. Troy.
- 1 8 *Louvain*, as *Arshot*.  
 1 1 *Lubeck*, as *Copenhagen*.  
 1 7 *Luca*, as *Aquila*.



- 100 lb. Ordinary Weight. A Centener is 112 lb.
- 102 lb. Almerick, or Weight of Geneva for Spices, abating 8 lb. per Cent.
- 1 3 Lyons, 94  $\frac{1}{4}$  lb. by the King's Weight to pay Custom by. A Quintal is 100 lb. A Charge 300 lb. A Somme 400 lb.
- 3 3 Medera, as *Caba Verdo*.
- 1 8 Malines, or *Mecklin*, as *Arſchot*.
- 1 7 Mantua, as *Aquila*.
- 1 3 Marſeilles, 111 lb.
- 3 2 Maroco, or *Morocco*, as *Caba Verdo*.
- 1 14 Medina del Camporas *Caſtile*.
- 1 9 Melvin, 124 lb. The Laſt of Wheat 5200 lb. The Skippound and Stone, as *Coningsberg*.
- 100 lb. of 16 Oz. to the lb. which is the Princes Weight, called
- 1 4 Meyſen, } *Zigſtatica*.  
96 lb. Merchants Weight.  
184 lb. of 12 Oz. to the lb.
- 1 7 Milan, as *Cremona*.
- 1 3 Mirabel, as *Aquiſmort*.
- 1 7 Mirandula, as *Aquila*.
- 1 7 Modena, as *Faenza*.
- 2 7 Molucco, 88 Rotuli, 112 a Cantar.
- 1 3 Montpelier, as *Avignon*.
- 1 4 Munchen, as *Aufburg*.
- 1 7 Naples, 120 lb. and for *Venice* Gold 134 lb.
- 1 15 Nareca, 120 lb. A Liſpound, or Stone, is 20 lb. and 20 Liſpound a Skippound, that is 400 lb. uſed for Rye, but for Wheat but 350 lb. to a Skippound.
- 1 7 Nicoſia, or *Nichoſia*, as *Archipelago*.
- 1 5 Negropont, 119 lb.
- 1 4 Nurenburg, as *Conſtance*.
- 1 4 Norlingen, as *Aufburg*.
- 1 4 Offen, or *Buda*, as *Baſil*.
- 94 Rotuli, 1 Cantar 5 Rooves, 1 Roove 20 Rotuli.
- 138 lb. for Spices, 1 Cantar 4 Rooves.
- 3 2 Oran, } 50 Rotuli for Corn, 1 Cantar 6 Rotuli.  
61 Rotuli for Cotton-wool, 1 Cantar 15 Rotuli.
- 1 7 Otranto, } as *Bergamo*.
- 1 7 Padua, }
- 1 3 Paris, 93 lb. accounting 4 Quarters of 25 lb. to the Hundred.
- 1 7 Parma, as *Aquila*.
- 1 4 Paſſau, 87 lb.
- 1 7 Pavia, as *Cremona*.
- 1 7 Piſa, as *Venice*.
- 1 6 Piedmont, } as *Aquila*.
- 1 7 Plaiſſance, }
- 1 4 Poſen, as *Breſlaw*.
- 1 8 Popering, as *Ailoſt*.
- 1 10 Portugal, 107  $\frac{1}{2}$  Rotuli, or Araters. The great Quintal is 128 lb. of 4 Rooves, 1 Roove 32 lb. The ſmall Quintal is 112 lb. of 4 Rooves, 1 Roove 28 lb. The Quintal of Wax 168 lb. which is 1  $\frac{1}{2}$  Quintal of 122 lb. of 4 Rooves of 42 lb. the Roove.
- 1 4 Prague, as *Paſſau*.
- 1 7 Puglia, as *Calabria*.
- 1 7 } *Raguza*, } as *Faenza*.  
1 7 } *Raviano*, }  
1 7 } *Ravenna*, }
- 1 7 Rechanati, 137 lb. but to Gold-thread, but 112 lb.
- 1 4 Regensbourg, as *Paſſau*.
- 1 15 Revell, 120 lb. which is a Centener. The Skippound there is 400 lb.
- 2 1 Rhodes, 19  $\frac{1}{2}$  Rotuli, a Cantar is 100 lb.
- 1 9 Riga, 120 lb. a Liſpound is 20 lb. and 20 Liſpound a Skippound.
- 1 7 Rimano, as *Faenza*.
- 1 3 Rochel, 111 lb. and 119 lb. by the ſmall Weight.
- 1 7 Romagna, as *Naples*.
- 1 3 Roven, or } 91 lb. by the *Viconte*, according  
Roan. } as at *Paris*.  
94  $\frac{1}{4}$  lb. by the Ordinary Weight, and 4 lb. per Cent.
- 1 4 Saltz- } 111 lb. ſmall Weight.  
bourg, } 83 lb. great Weight.
- 1 3 St. Antoine, 127 lb.
- 1 8 St. Omar, as *Audenarde*.
- 3 3 St. Thomas, as *Cabo Verde*.
- 2 14 Saragoſſa, 112 lb. And the ſmall Quintal 131 lb.
- 1 7 Savoy, } 137 lb.  
195 lb. ſmall Weight.
- 1 4 Saxony, as *Meiſen*.
- 3 1 Sciba, as *Antwerp*, 320 lb. is there a Skippound.
- 2 1 Scio, as *Fio*.
- 1 13 Sequia, as *Venice*.
- The great Quintal is 144 of 4 Rooves of 36 lb.
- 1 14 Sevil 107 lb. } The leſſer Quintal is 120 lb. of 4 Rooves of 30 lb.  
The ſmall Quintal is 112 lb. of 4 Rooves of 28 lb.
- 1 7 Cicilia 152 lb. of 12 Oz. per lb. 61 Rotuli of 30 Oz. is a Cantar of 24 Seſtertio's. 54 Rotuli for Fleſh by Talents of 12 Seſtertio's, is 30 Rotuli.
- 1 7 Sileſia, as *Breſlaw*.
- 1 13 Spoletto, as *Venice*.
- 1 4 Spires, as *Bibrach*.
- 1 4 Stetin 96 lb. The ſmall Stone 10 lb. The great Stone 21 lb. The Centener 112 lb.
- 1 15 Stockholm 120 lb. The Skippound 320 lb. and alſo 340 lb. The Centener 120 lb. The Stone 10 lb.
- 1 4 Straelfond 92 lb. The Stone 10 lb. and the Liſpound 16 lb.
- 3 2 Suus, or Sus, or Fex.
- 2 11 Syria 156 Mina's, a Mina 100 Drachms.
- 1 8 Tergos 107 lb.
- 1 3 Thoulouſe, as *Avignon*.
- 3 2 Thunes, or Tunis, 63 Rotuli.
- 1 9 Thoren 120 lb. The Stone is 24 lb.
- 1 8 Tournay, as *Ailoſt*.
- 1 7 Treviſo, as *Bergamo*.
- 1 7 Trieſte, as *Venice*.
- 3 2 Tripoli, as *Tunis*.
- 2 11 Tripoli 26  $\frac{1}{2}$  lb.



1 14 *Valentia*, { 106 lb. by Quintals of 4 Rooves  
of 30 lb. for Spices.  
134 by Quintals of 4 Rooves of  
36 lb.

The small Carga is 360 lb. that is, three Quintals of 120 lb.

The great Carga is 432 lb. that is, three Quintals of 144 lb.

1 7 *Venice*, { 98  $\frac{2}{3}$  lb. Great Weight, called *Ala Grossa*, used for Flesh, Butter, Cheese, Leather, Dates, Yarn, Copper, Thread, Iron, Oil, Brimstone and Wool.  
150 lb. Small Weight of 12 Oz. called *Ala Sotile*, most used for all Merchandize.

An Ounce is 8 Saffi, a Saffi 24 Carrats, 1 Carrat 4 Grains. They also account by Thousands, &c. with Allowance of 2 lb. *per Cent.* in the *Custom-house*.

1 Thousand 40 Mixti, 1 Mixti 25 lb.

1 Carga 400 lb. 1 Starre 220 lb. The Starre is mensural. Starres for Corn 130 lb. Ginger 180 lb. Raifon, 260 lb. The Starre contains 54 Pottles of Wine at *Antwerp*.

1 7 *Verona* 90 lb. And for Gold-thread 143 lb.

1 4 *Vienna* 85 lb. as at *Erfurd*; where also a Somme of Quicksilver is 275 lb.

1 14 *Villaco*, as *Vellica*, 80 lb.

1 4 *Ulm*, as *Basil*.

3 2 *Una*, { 65 Rotuli for Cotton.  
75 Rotuli for Spices.  
94 Rotuli for Corn.

1 7 *Urbino*, as *Bergamo*.

*Walloon* Country, as *Alost*.

1 8 *Walstand*, as *Guelderland*.

1 9 *Wilde*, as *Riga*.

1 4 *Wisel*, as *Ausburgh*.

3 1 *Zaidin* 77 Rotuli.

1 8 *Zeland*, as *Guelderland*.

3 1 *Zeroi* 50 Rotuli.

1 8 *Zurich-zee* 100 lb.

#### Foreign Weights for Money.

In *Florence* they use a Weight for Gold and Silver; and at *Geneva* for Silver, called a Pound, of 12 Oz. 1 Oz. is 24 Deniers, and 1 Denier is 24 Grains: So is their 6912 Grains in the Pound.

In *Naples*, their Pound is likewise divided into 12 Ounces, and every Ounce into 8 Octany, or Actavos.

The Mark Weight is used in many other Places, and at *Antwerp* containeth 8 Ounces, and is heavier than their ordinary Pound by 5 upon the Hundred, as *Malines* faith.

This Mark is divided in a double Manner.

|           | Ounces. | Englsh. | Grains. |
|-----------|---------|---------|---------|
| (1) Mark. | 8       | 160     | 5120    |
|           | Ounce.  | 20      | 640     |
|           |         | Englsh. | 32      |

|           | Ounces. | Penny-weights | Grains. |
|-----------|---------|---------------|---------|
| (1) Mark. | 8       | 192           | 4608    |
|           | Ounce.  | 24            | 576     |
|           |         | Penny-weight. | 24      |

The Mark Weights of some other Places subdivided.

#### FRANCE.

|       | Ounces. | Grosses. | Deniers. | Grains. | Primes, or Garods. | Seconds. | Tercies, or Malloquen. |
|-------|---------|----------|----------|---------|--------------------|----------|------------------------|
| Mark. | 8       | 64       | 192      | 4608    | 110592             | 2654208  | 63700992               |
|       | Ounce.  | 8        | 24       | 576     | 13824              | 331776   | 7962624                |
|       |         | Gross.   | 3        | 72      | 1728               | 41472    | 995328                 |
|       |         |          | Denier.  | 24      | 576                | 13824    | 331776                 |
|       |         |          |          | Grain.  | 24                 | 576      | 13824                  |
|       |         |          |          |         | Garob, or Prime.   | 24       | 576                    |
|       |         |          |          |         |                    | Second.  | 24                     |



In *France*, that Ounce is also divided into 2 Carrats, and every Carrat into 12 Grains.

*Dantzick in Poland.*

|       | Ounces. | Pence. | Hellers. |
|-------|---------|--------|----------|
| Mark. | 8       | 256    | 512      |
|       | Ounce.  | 32     | 64       |
|       |         | Penny. | 2        |

*Geneva for Gold.*

|       | Ounces. | Deniers. | Grains. |
|-------|---------|----------|---------|
| Mark. | 8       | 192      | 4608    |
|       | Ounce.  | 24       | 576     |
|       |         | Denier.  | 24      |

*Meisen in Saxony.*

|       | Ounces. | Deniers.                | Grains,<br>or<br>Momenta. |
|-------|---------|-------------------------|---------------------------|
| Mark. | 8       | 192                     | 4608                      |
|       | Ounce.  | 24                      | 576                       |
|       |         | Denier,<br>or<br>Penny. | 24                        |

*Portugal.*

|       | Ounces. | Oitavos,<br>or<br>Oitavos. | Great<br>Grain. |
|-------|---------|----------------------------|-----------------|
| Mark. | 8       | 64                         | 288             |
|       | Ounce.  | 8                          | 36              |
|       |         | Oitavo,<br>or<br>Oitavo.   | 4 $\frac{1}{2}$ |

*Nurenburch in Germany.*

|       | Ounces. | Loots. | Quints. | Primes.                             | Setertios. |
|-------|---------|--------|---------|-------------------------------------|------------|
| Mark. | 8       | 16     | 64      | 256                                 | 1024       |
|       | Ounce.  | 2      | 8       | 32                                  | 128        |
|       |         | Loot.  | 4       | 16                                  | 64         |
|       |         |        | Quint.  | 4                                   | 16         |
|       |         |        |         | Prime,<br>Penny,<br>or<br>Nummulus. | 4          |

*Venice.*

|       | Ounces. | Silicos,<br>or<br>Quarts. | Siliquas,<br>or<br>Carrats. | Grains. |
|-------|---------|---------------------------|-----------------------------|---------|
| Mark. | 8       | 32                        | 1151                        | 4608    |
|       | Ounce.  | 4                         | 144                         | 576     |
|       |         | Silico,<br>or<br>Quart.   | 36                          | 144     |
|       |         |                           | Siliquas,<br>or<br>Carrat.  | 4       |

*Spain. Gold.*

|       | Ounces. | Castel-<br>lanos. | Tomines. | Grains. |
|-------|---------|-------------------|----------|---------|
| Mark. | 8       | 50                | 400      | 4800    |
|       | Ounce.  | 6 $\frac{1}{2}$   | 50       | 600     |
|       |         | Castel-<br>lano.  | 8        | 96      |
|       |         |                   | Tomine.  | 12      |

*Spain. Silver.*

|       | Ounces. | Drams,<br>or<br>Oitavo. | Grains. |
|-------|---------|-------------------------|---------|
| Mark. | 8       | 64                      | 4800    |
|       | Ounce.  | 8                       | 600     |
|       |         | Dram,<br>or<br>Oitavo.  | 75      |

*Rome.*

|       | Ounces. | Drams. | Scru-<br>ples. | Obolos. | Sili-<br>quas. | Primi,<br>or<br>Grains. |
|-------|---------|--------|----------------|---------|----------------|-------------------------|
| Mark. | 8       | 64     | 192            | 384     | 1152           | 4608                    |
|       | Ounce.  | 8      | 24             | 48      | 144            | 576                     |
|       |         | Dram.  | 3              | 6       | 18             | 72                      |
|       |         |        | Scru-<br>ple.  | 2       | 6              | 24                      |
|       |         |        |                | Obolus. | 3              | 12                      |
|       |         |        |                |         | Sili-<br>qua.  | 4                       |



Roman Libra, by *Malines*.

|       |         |           |           |            |           |            |            |
|-------|---------|-----------|-----------|------------|-----------|------------|------------|
| Libra | 12      | 84        | 162       | 336        | 840       | 3320       | 5040       |
|       | Ounces. | Guilfers. | Denarios. | Viciorias. | Sesteris. | Quadrants. | Sextantes. |

The Ton of Gold in *Latin*, *Tina*, seu *Tonna*, by some called *Roman*; but by *Alsted*, *German*, is thus divided.

|              | Pounds.           | Marks.             | Ounces. | Loots. | Drams. |
|--------------|-------------------|--------------------|---------|--------|--------|
| Ton of Gold. | 781 $\frac{1}{4}$ | 1562 $\frac{1}{2}$ | 12500   | 25000  | 100000 |
|              | Pound.            | 2                  | 16      | 32     | 128    |
|              |                   | Mark.              | 8       | 16     | 64     |
|              |                   |                    | Ounce.  | 2      | 8      |
|              |                   |                    |         | Loot.  | 4      |

*Scotland* divides their Pound into 24 Deniers, 1 Denier 24 Primes, 1 Prime 24 Seconds, 1 Second 24 Thirds, 1 Third 24 Fourths, &c.

The Correspondency of 100 Marks of *Antwerp*, to the Places following.

|   |                     |                          |
|---|---------------------|--------------------------|
|   | <i>Alder</i>        | 76 $\frac{1}{2}$ lb.     |
| 3 | 1 <i>Egypt</i>      | 94 Bessles               |
| 3 | <i>Africa</i>       | 87 Marks                 |
| 1 | 7 <i>Ancona</i>     | 103 $\frac{1}{4}$ Marks  |
| 1 | 7 <i>Aquila</i>     | 71 lb.                   |
| 1 | 4 <i>Ausburgh</i>   | 105 $\frac{2}{9}$ Marks. |
| 1 | 4 <i>Bambergh</i>   | 103 $\frac{1}{4}$ Marks  |
| 1 | 4 <i>Bavaria</i>    |                          |
| 1 | 4 <i>Bohemia</i>    | 87 Marks                 |
| 1 | 4 <i>Breslaw</i>    | 121 $\frac{3}{4}$ Marks  |
| 1 | 14 <i>Burgas</i>    | 116 $\frac{2}{3}$ Marks  |
| 1 | 7 <i>Calabria</i>   | 76 $\frac{1}{2}$ lb.     |
| 1 | 14 <i>Catalonia</i> | 100 Marks.               |

|   |                                   |   |
|---|-----------------------------------|---|
| 1 | 4 <i>Cologn</i>                   | 105 $\frac{2}{9}$ Marks                                       |
| 1 | 5 <i>Constantinople</i>           | 87 Marks  |
| 1 | 7 <i>Crema</i>                    | 103 $\frac{1}{4}$ Marks                                       |
| 1 | 9 <i>Dantzick</i>                 | 105 $\frac{2}{9}$ Marks                                       |
| 1 | 4 <i>Erfurd</i>                   |   |
| 1 | 7 <i>Florence</i>                 | 72 lb.  |
| 1 | 4 <i>Franconia</i>                | 103 $\frac{1}{4}$ Marks                                       |
| 1 | 4 <i>Frankford</i>                | 105 $\frac{2}{9}$ Marks                                       |
| 1 | 4 <i>Friburgh</i>                 | 103 $\frac{1}{4}$ Marks                                       |
| 1 | 7 <i>Genes</i> for { Gold         | 116 Marks   |
|   |                                   | { Silver 77 Marks lb.   |
| 1 | 7 <i>Geneva</i> as <i>Paris</i>   | 105 $\frac{2}{9}$ Marks                                       |
|   | and <i>Lyons</i>                  |   |
| 8 | 7 <i>Græcia</i>                   | 87 Marks  |
| 1 | 4 <i>Hungary</i>                  | 105 $\frac{2}{9}$ Marks                                       |
| 1 | 4 <i>Leipsick</i>                 | 89 $\frac{2}{9}$ lb.  |
| 1 | 2 <i>London</i>                   | 112 Marks, Merchants Weight                                   |
| 1 | 3 <i>Lyons</i>                    | 102 $\frac{1}{2}$ Marks, Merchants Weight. The King's Weight, |
| 1 | 4 <i>Ments</i>                    | 105 $\frac{2}{9}$ Marks                                       |
| 1 | 4 <i>Meisen</i>                   |   |
| 1 | 7 <i>Millan</i>                   | 79 $\frac{1}{2}$ lb.  |
| 1 | 7 <i>Naples</i>                   |   |
| 2 | 6 <i>Narsinga</i>                 | 87 Marks  |
| 1 | 4 <i>Nurenburgh</i>               | 103 $\frac{1}{4}$ Marks                                       |
| 4 | 2 <i>Nova Spagnia</i>             | 87 $\frac{1}{2}$ Marks  |
| 1 | 3 <i>Paris</i> , as <i>Lyons</i>  | 87 Mina's   |
| 2 | 9 <i>Persia</i>                   |   |
| 4 | 3 <i>Peru</i>                     | 87 $\frac{1}{2}$ Marks  |
| 1 | 7 <i>Piedmont</i>                 | 99 Marks  |
| 1 | 7 <i>Puglia</i>                   | 76 $\frac{1}{2}$ lb.  |
| 1 | 7 <i>Rome</i>                     | 103 $\frac{1}{4}$ Marks                                       |
| 1 | 4 <i>Saxon</i>                    | 105 $\frac{2}{9}$ Marks                                       |
| 1 | 14 <i>Spain</i>                   | 107 Marks   |
| 1 | <i>Trevers</i> , or <i>Triers</i> | 105 $\frac{2}{9}$ Marks                                       |
| 1 | 7 <i>Trevifo</i>                  | 103 $\frac{1}{4}$ Marks                                       |
| 1 | 7 <i>Turin</i>                    | 99 Marks  |
| 2 | } <i>Turkey</i>                   | 87 Marks  |
| 3 |                                   |   |
| 1 | 7 <i>Venice</i>                   | 103 $\frac{1}{4}$ Marks                                       |
| 1 | 7 <i>Verona</i>                   |   |
| 1 | 7 <i>Vicenza</i>                  | 105 $\frac{2}{9}$ Marks                                       |
| 1 | 4 <i>Vienna</i>                   | 87 Marks  |
| 1 | 4 <i>Ulm</i>                      | 105 $\frac{2}{9}$ Marks                                       |
| 1 | 4 <i>Wissilbourg</i>              | 103 $\frac{1}{4}$ Marks.                                      |



## A TABLE of Grecian Attick Weights.

|           | Pounds<br>Minas. | Ounces<br>Uncias. | Drams<br>Dra-<br>chmas. | Scruples<br>Gram-<br>mata. | Obolos. | Lupines<br>Termes. | Kiratiās<br>Siliquas. | Aereolās<br>Chalkos. | Grains.<br>Sitar. | Minutes<br>Leptos. |
|-----------|------------------|-------------------|-------------------------|----------------------------|---------|--------------------|-----------------------|----------------------|-------------------|--------------------|
| Talent. { | Greater.         | 80                | 1000                    | 8000                       | 24000   | 48000              | 72000                 | 144000               | 288000            | 576000             |
|           | Lesser.          | 60                | 750                     | 6000                       | 18000   | 36000              | 54000                 | 108000               | 216000            | 432000             |
| Mina. {   | New              | 12 $\frac{1}{2}$  | 100                     | 300                        | 600     | 900                | 1800                  | 3600                 | 7200              | 25200              |
|           | Old.             | 9 $\frac{3}{8}$   | 75                      | 225                        | 450     | 675                | 1350                  | 2700                 | 5400              | 18900              |
| a         |                  | Uncia             | 8                       | 24                         | 48      | 72                 | 144                   | 288                  | 576               | 2016               |
|           |                  | Ounce.            | b                       | Drach.                     | 3       | 6                  | 9                     | 18                   | 36                | 72                 |
|           |                  |                   | Dram.                   | c                          | Gram-   | 2                  | 3                     | 6                    | 12                | 24                 |
|           |                  |                   |                         | ma                         | Obolus. | 1 $\frac{1}{2}$    | 3                     | 6                    | 12                | 42                 |
|           |                  |                   |                         | Scruple                    | d       | e                  | Thermie               | 2                    | 4                 | 8                  |
|           |                  |                   |                         |                            |         |                    | Lupine.               | f                    | 2                 | 4                  |
|           |                  |                   |                         |                            |         |                    | Siliqua               | g                    | 2                 | 4                  |
|           |                  |                   |                         |                            |         |                    | Kiration.             | g                    | 2                 | 7                  |
|           |                  |                   |                         |                            |         |                    | Chalkus               | h                    | 2                 | 3 $\frac{1}{2}$    |
|           |                  |                   |                         |                            |         |                    | Aerolus.              | h                    |                   |                    |
|           |                  |                   |                         |                            |         |                    | Sitar                 | i                    |                   |                    |
|           |                  |                   |                         |                            |         |                    | Grain.                | i                    |                   |                    |
|           |                  |                   |                         |                            |         |                    |                       | k                    |                   |                    |

## Grecian Physical Weights.

|        | Uncias.<br>Ounces. | Dra-<br>chmas.<br>Drams. | Scruples<br>Gram-<br>mata. | Obolos. | Lupines.        | Carobseeds.<br>Keratiās.<br>Siliquas. | Aerola.<br>Chalkos. | Grains.<br>Sitar. | Minutes.<br>Leptās. |
|--------|--------------------|--------------------------|----------------------------|---------|-----------------|---------------------------------------|---------------------|-------------------|---------------------|
| Mina.  | 16                 | 128                      | 384                        | 768     | 1152            | 2304                                  | 4608                | 9216              | 32256               |
| Litra. | 12                 | 96                       | 288                        | 576     | 864             | 1728                                  | 3456                | 6912              | 24192               |
| a a    | Uncia.             | 8                        | 24                         | 48      | 72              | 144                                   | 288                 | 576               | 2016                |
|        | Ounce.             | b                        | Drach.                     | 3       | 6               | 9                                     | 18                  | 36                | 72                  |
|        |                    | Dram.                    | c                          | Gramma. | 2               | 3                                     | 6                   | 12                | 24                  |
|        |                    |                          | Scruple.                   | Obolus. | 1 $\frac{1}{2}$ | 3                                     | 6                   | 12                | 42                  |
|        |                    |                          |                            | Lupine. | 2               | 4                                     | 8                   | 28                |                     |
|        |                    |                          |                            |         |                 | Siliqua.                              | 2                   | 4                 | 14                  |
|        |                    |                          |                            |         |                 | Keration.                             |                     |                   |                     |
|        |                    |                          |                            |         |                 | Carobseed.                            | 2                   | 7                 |                     |
|        |                    |                          |                            |         |                 | Chalkus.                              |                     |                   |                     |
|        |                    |                          |                            |         |                 | Æreolum.                              |                     |                   |                     |
|        |                    |                          |                            |         |                 | Sitar.                                |                     | 3 $\frac{1}{2}$   |                     |
|        |                    |                          |                            |         |                 | Grain.                                |                     |                   |                     |
| I      |                    |                          |                            |         |                 |                                       |                     |                   |                     |



## Grecian Hippatrical or Farriers Weights.

|            | Ounces. | Dena-<br>rions.  | Drams.            | Scru-<br>ples.    | Obolos. |
|------------|---------|------------------|-------------------|-------------------|---------|
| Mina.      | 15      | 84 $\frac{3}{8}$ | 112 $\frac{1}{2}$ | 337 $\frac{1}{2}$ | 675     |
| Litra.     | 12      | 67 $\frac{1}{2}$ | 90                | 270               | 540     |
| aaa Ounce. |         | 5 $\frac{1}{8}$  | 7 $\frac{1}{2}$   | 22 $\frac{1}{2}$  | 45      |
|            |         | Dena-<br>rion.   | 1 $\frac{1}{3}$   | 4                 | 8       |
|            |         | bb Dram.         | 3                 |                   | 6       |
|            |         | cc               |                   | Scru-<br>ple.     | 2       |

II

a. The *Mina* of 100 Drachms is called *Solon's Mina*, because thought to be continued by him sometime turned into *Latin* by *Mina*, often by *Libra*, tho' *Libra* be 4 Drachms lighter, the *Roman Libra* being but 96 *Attick* Drachms. The old *Mina* of 75 Drachms, now absolute, for Memory sake, hath found Room in this Table.

aa. The Physicians, as by *Dioscorides* and *Galen* appears, used a *Mina*, or Pound of 16 Ounces, and a *Litra* or other Pound of 12 Ounces, conceived all one with the *Roman Libra*, consisting of 96 Drachms, as they did; and by Interpreters commonly rendred *Libra*; and seldom or never *Mina*; and *Mina*, and *Litra*, as also *Libra* commonly englished a Pound.

aaa. The *Hippiatrick* had a *Mina* of 15 Ounces, and a *Litra* of 12.

b. *Oungia*, in *Latin* *Uncia*, must not be taken for our Ounce, but for one of their Ounces, arising by the Division of their Pound into Drachms differently, according to the Quantity of Drachms in one Pound.

bb. Among the *Hippatrical* Weights there was a *Denarium* of 4 Scruples, 5  $\frac{1}{2}$  whereof made one of their Ounces.

c. *Drachme*, *Drachma*, and *Dragma*, in *Greek* and *Latin*, in *English* a *Dram*, is the 8th Part of their Ounce, whereby the Pound hath 12 or 16 Ounces therein. By *Alsted* made to equal the *German* Weight *Quinclein*. Some call a *Dram* *Refolus*, some *Holke*, from the *Greek*  $\rho\lambda\eta\kappa\eta$ .

cc. The Ounce *Hippiatrick*, that divided as well the *Mina* of 15 Ounces, as the *Litra* of 12 Ounces, had but 7  $\frac{1}{2}$  Drams into it.

d. Drams of all sorts were parted into 3 Scruples. A Scruple in *Greek* sometime *Gramma*, sometimes *Grammata*; in *Latin* *Scripulum*, *Scriptulum*, and *Scrupulum*.

e. *Obolus*, sometime a Weight, sometime a Piece of Money, commonly rendred an Half-Penny, because always was the half of a Scruple.

f. *Lupine*, in *Greek* *Therma's*, was a Weight equal in poise to the *Lupine*, which is a Seed grow-

ing in a Cod like to a Pease, and both Plant and Seed bear that Name. And seeing there are many sorts, as *Perkinson's Theatre of Plants*, pag. 1073, which sort of *Lupine* is meant, is uncertain; probably, the middle White, which are most in use, bigger than the Yellow, and not so big as the great Blue; and from the nearness in Weight thereto, if not exactness, might be so called.

g. gg. *Siliquea*, in *Greek* *Keration*, a Weight, a like heavy to the *Carobseed* or sweet Bean; common in many Countries subject to the *Grecian* Empire: Sometime called *Carat* or *Caract*, from whence the Word is still in use with us.

h. *Chalkos*, in *Latin* *Aerolus* and *Aerolum*. *Aerolus* was also a Piece of Brass Money current in ancient Times among those Countries of the *Grecian* Dominion.

i. *Sitar*; a Grain of Corn from  $\Sigma\tau\tau\circ$  *Frumentum*, likely to have been the Original of their Weight, two whereof make one *Chalkos*.

k. *Lepton*; from *Leptos*, in *Latin* *Minutum*, and *Minutia*, supposed to be some small Scale of the Rhind or Bark of some Tree, 3  $\frac{1}{2}$  balanced the *Sitar*.

l. Besides these, in the Table of Physical Weights some Books mention the *Affarian*, allowed for two Drachms, which is  $\frac{1}{4}$  part of an Ounce. Also, the *Exagion*, wrote sometime *Stagion*, sometime *Agion* for Brevity, which was the *Roman Sextula*, the 6th part of their Ounce, whereof 12 make the *Litra*. Likewise *Orobis*, which was a Grain of a wild Vetch. And *Phaike* a Lentil; but whether Weights or no, is not worth the Enquiry.

ll. As the other Weights are divided into lesser Divisions than the *Obolos*, so no doubt but the *Hippiatrick* also were, and may accordingly be done, when occasion serves; the *Obolus* of all sorts admitting the like smaller Denominations.

## Grecian Exotick Weights.

|           |  |                                      |                   |
|-----------|--|--------------------------------------|-------------------|
|           | Mention'd by <i>Vetruvius</i> ,<br>suppos'd to be <i>Thra-</i><br><i>cian</i> , or <i>Byzantium</i><br>Talent. | 120                                  |                   |
| Talents   | Several mentioned by<br><i>Hesychius</i> .   | 100<br>125<br>165<br>405<br>1150     | Libras.           |
|           | Old } <i>Sicilian (m)</i><br>New }   | 24<br>12                             | Minas.            |
|           | <i>Alexandria</i><br><i>Aegina</i> }<br><i>Corinth</i> }   | 12000<br>10000                       |                   |
| Talent of | <i>Egypt</i><br><i>Babylon</i><br><i>Rhodium</i><br><i>Euboicum</i><br><i>Syria</i>                            | 8000<br>7000<br>4500<br>4000<br>1500 | Attick.<br>Drams. |
| Mina      | <i>Alexandria</i><br><i>Ptolemaica</i>   | 20<br>18                             | Uncias.           |
| Drachma   | <i>Egyptia</i>   | 12                                   | Obolus.           |



A Table of the *Roman* Weights.

|                        | <i>Mi-</i><br><i>nas.</i> | <i>Li-</i><br><i>bras.</i> | <i>Un-</i><br><i>cias.</i> | <i>Semi-</i><br><i>un.</i> | <i>Duel-</i><br><i>lis.</i> | <i>Sici-</i><br><i>lias.</i> | <i>Sex-</i><br><i>tulas.</i> | <i>Dena-</i><br><i>rios.</i> | <i>Drachms</i> | <i>Quinars.</i> | <i>Scruples.</i> | <i>Quadr.</i> | <i>Sext.</i> | <i>Obol.</i> | <i>Siliq.</i> | <i>Grains.</i> |
|------------------------|---------------------------|----------------------------|----------------------------|----------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|----------------|-----------------|------------------|---------------|--------------|--------------|---------------|----------------|
| <i>Talent.</i>         | 75                        | 152                        | 150                        | 3000                       | 4500                        | 6000                         | 9000                         | 10500                        | 12000          | 21000           | 36000            | 42000         | 63000        | 72000        | 216000        | 864000         |
| <i>Mina.</i>           | $1\frac{2}{3}$            | 20                         | 40                         | 60                         | 80                          | 120                          | 140                          | 160                          | 280            | 480             | 560              | 840           | 960          | 2880         | 11520         |                |
| <i>Libra</i><br>a      | 12                        | 24                         | 36                         | 48                         | 72                          | 84                           | 96                           | 168                          | 288            | 336             | 504              | 526           | 1728         | 6912         |               |                |
| <i>Uncia</i>           | 2                         | 3                          | 4                          | 6                          | 7                           | 8                            | 14                           | 24                           | 28             | 42              | 48               | 144           | 576          |              |               |                |
| <i>Semiuncia.</i><br>b | $1\frac{1}{2}$            | 2                          | 3                          | $3\frac{1}{2}$             | 4                           | 7                            | 12                           | 14                           | 21             | 24              | 72               | 288           |              |              |               |                |
| <i>Duella</i><br>c     | $1\frac{1}{2}$            | 2                          | $2\frac{1}{3}$             | $2\frac{2}{3}$             | $4\frac{2}{3}$              | 8                            | $9\frac{1}{3}$               | 14                           | 16             | 48              | 192              |               |              |              |               |                |
| <i>Sicilium.</i><br>d  | $1\frac{1}{2}$            | $1\frac{3}{4}$             | 2                          | $3\frac{1}{2}$             | 6                           | 7                            | $10\frac{1}{2}$              | 12                           | 36             | 144             |                  |               |              |              |               |                |
| <i>Sextula.</i><br>e   | $1\frac{1}{6}$            | $1\frac{1}{2}$             | $2\frac{1}{3}$             | 4                          | $4\frac{2}{3}$              | 7                            | 8                            | 24                           | 96             |                 |                  |               |              |              |               |                |
| <i>Denarius.</i><br>f  | $1\frac{1}{7}$            | 2                          | $3\frac{3}{7}$             | 4                          | 6                           | $6\frac{6}{7}$               | $20\frac{4}{7}$              | $82\frac{2}{7}$              |                |                 |                  |               |              |              |               |                |
| <i>Drachm.</i>         | $1\frac{3}{4}$            | 3                          | $3\frac{1}{2}$             | $5\frac{1}{4}$             | 6                           | 18                           | 72                           |                              |                |                 |                  |               |              |              |               |                |
| <i>Quinar.</i><br>g    | $1\frac{1}{7}$            | 2                          | 3                          | $3\frac{3}{7}$             | $10\frac{2}{7}$             | $41\frac{1}{7}$              |                              |                              |                |                 |                  |               |              |              |               |                |
| <i>Scruple.</i><br>h   | $1\frac{1}{8}$            | $1\frac{1}{4}$             | 2                          | 6                          | 24                          |                              |                              |                              |                |                 |                  |               |              |              |               |                |
| <i>Quadrans.</i><br>i  | $1\frac{1}{2}$            | $1\frac{1}{7}$             | $5\frac{1}{7}$             | $20\frac{4}{7}$            |                             |                              |                              |                              |                |                 |                  |               |              |              |               |                |
| <i>Sextans.</i><br>k   | $1\frac{1}{7}$            | $3\frac{3}{7}$             | $13\frac{5}{7}$            |                            |                             |                              |                              |                              |                |                 |                  |               |              |              |               |                |
| <i>Obolus.</i><br>l    | 3                         | 12                         |                            |                            |                             |                              |                              |                              |                |                 |                  |               |              |              |               |                |
| <i>Siliqua.</i>        | 4                         |                            |                            |                            |                             |                              |                              |                              |                |                 |                  |               |              |              |               |                |

a. *Libra*, called also *As*, by Translators commonly rendered a Pound, was divided into 12 Ounces, and for every Number of Ounces under 12, a proper Name used, as,

*Deunx*, \_\_\_\_\_ 11  
*Dextans* and *Decunx*, \_\_\_\_\_ 10  
*Dodrans*, \_\_\_\_\_ 9

\*\* *Bes*, *Bessis*, and of old, *Des*, \_\_\_\_\_ 8  
*Septunx*, \_\_\_\_\_ 7  
*Semis*, *Semissis*, *Semissius*, *Selibra*, and *Semibella*, \_\_\_\_\_ 6  
*Quincunx*, \_\_\_\_\_ 5  
*Triens*, \_\_\_\_\_ 4  
*Quadrans* and *Triunx*, \_\_\_\_\_ 3  
*Sextans*, \_\_\_\_\_ 2  
*Uncia*, \_\_\_\_\_ 1 } *Ounces.*

*Malines*, p. 24. of his *Lex Mercatoria*, divides *Pondus*, which he calls the Old Pond of the *Romans*, into

64 *Denario's*.  
129 *Quinario's*.  
256 *Sestertio's*.  
640 *Affes*.  
1280 *Semilibella's*.  
2560 *Teruncio's*.

A Reason is wanting, why *Legat* makes the *Roman Libra* of 12 Oz. but  $10\frac{1}{2}$  Oz. *Troy*, since if he reckon by the Number of Grains (the Original of Weights) at 5760 Grains of Assize in the Pound *Troy*, it can be but 10 Oz. just; for 10 times 6912, the Grains in a *Roman* Pound, and 12 times 5760 are equal: But if he count the Pound *Troy* at 7680 Grains, according to the Statute at 32 Grains of Wheat to a Penny-weight, the *Troy* Pound will be  $13\frac{1}{3}$  Oz. *Roman*.

\*\* *Bes*, is the Mark Weight, two Thirds of the

Pound, *Malines*, p. 24. afore said, makes the *Bes*, or old Mark of the *Romans*, to be divided into

16 *Loot*, or *Tetradrams*.  
 $23\frac{1}{3}$  *Tridrams*.  
32 *Didrams*.  
64 *Drachms*.  
96 *Obolos*, or *Treobolos*.  
128 *Triobolos*.  
384 *Obolos*.  
768 *Miobolos*.  
3840 *Moments*.

b *Semiuncia*, or the Half-Ounce, is sometimes called *Affarion*, and *Affarius*, and by *Asted*, *Lotho*, answering to a *German* Weight of that Name.

c *Duella* being double to the Weight of the *Sextula*, sometimes called *Binae Sextulae*.

d *Sicilicum*, or *Sicilicus*, and, by Abbreviation, *Siclus*, is  $\frac{1}{4}$  of an Ounce.

e *Sextula*, used promiscuously with *Sextans*, and understood by Import of the Name to be the sixth Part.

f *Denarius*,



f *Denarius*, a Penny-weight, the 7th Part of an Ounce, whether used to weigh any thing but Money, as other; the Divisions thereof, somewhat questionable, see among the Money. *Alsted* compares the *Drachmal Denarius* to the German Weight *Quintlein*.

g *Quinar*, was half the Penny-weight, and a Piece of Money set afterward among the Roman Coin.

h Between the *Quinar* and *Scruple* some mention a Weight called *Tremissis*, containing 32 Grains, being the 18th Part of an Ounce.

i *Quadrans*, here is  $\frac{1}{4}$  of a Penny-weight, and so called *Quadrans Denarii*, to distinguish it from *Quadrans Libræ*, which was 3 Oz.

k *Sextans*, called *Sextans Denarii*, to difference it from *Sextans Libræ*, was the 6th Part of the Penny-weight, and sometime called *Sextula*.

l *Obolus*, or half a *Scruple*, called sometimes *Simplium*, weight 12 Grains. If there be another *Obolus*, as some say, which was the third Part of a *Quinar*, it seems to be a Piece of Coin, and must weigh  $13\frac{1}{3}$  Grains, and so is all one with the *Sextans*, according to the *Tabulary* Division; yet this sort of *Obolus* they make to contain but 10 Grains.

Between the *Obolus* and the *Siliqua* some mention a *Cerates*, which they say contains six Grains, and so is  $\frac{1}{2}$  the *Obolus*, or  $\frac{1}{4}$  of the *Scruple*.

#### *A Table of the Scripture-weights, from Bishop Cumberland.*

1. A Shekel of Silver was just half the Roman Ounce; or our Half-Ounce *Averdupois*, and was equal to 219 Grains *Troy*; and its Value in our Money was 28 Pence, or 2 Shillings, 4 Pence, Farthing, and near  $\frac{1}{8}$  Part of a Farthing: from whence 'tis easy to know the half and quarter Shekel.

2. The half Shekel was called *Bekoh*.

3. Its 20th Part was called *Gerah*, *Agurah*, and *Keshitah*, and is well translated by *Obolus Atticus*.

4. A Talent of Silver was 3000 Shekels, and in our Money its Value was 353 *l.* 11 *s.* 10 *d.*  $\frac{1}{2}$ .

5. A Talent of Gold was in Value of our Money 5076 *l.* 3 *s.* 10 *d.*

6. The *Maneh* was in Weight 100 Shekels, in Value or Coin 60 Shekels.

7. The Golden Darios, or *Persian* Drachmon, was in Weight 12 *Gerahs*, in Value 1 *l.* 0 *s.* 4 *d.*

8. The Roman Silver Denarius was 7 *d.* 3 *f.* Gold Coins double in Weight.

9. The Roman Brazen, or Copper *As*, was of  $\frac{1}{2}$  an Ounce Weight; in Value 3 Farthings, and one Tenth of our Farthing.

10. *Affarium* was the Half of the *As*, viz. 1 *f.* 55 nearly.

11. The *Quadrans* was in Value about  $\frac{3}{4}$  quarters of a Farthing.

12. The *Mite*, or *Asperon*, was the Half of the *Quadrans*, in Value about  $\frac{1}{2}$  of our Farthing.

WELDING-HEAT, is a Degree of Heat which Smiths give their Iron in the Forge, when there is occasion to double up the Iron, and to weld or work in the Doublings, so that the Iron shall grow a Lump thick enough for your purpose: 'Tis used also when two Bars of Iron are to be joined together at the ends, to make a Length.

WENDING, is a Term for bringing a Ship's Head about, and seems only to be a Corruption from Winding. They say, *How Wends the Ship?* i. e. Which way does her Head lie?

WEREGILD, *Wergeld*, *Wergildus*, also *Were* (*Werra*) alone without *Gild*, was formerly the Price that was paid partly to the King, and partly to the Relations of the Deceased, for killing a Man; when such Crimes were not punished with Death, but with pecuniary Mulcts.

WEST *Erect-Dials*: See *Direct Dials*.

WHEEL, or Way-wiser, an Instrument to measure Lengths upon the Ground: See *Perambulator*.

WHEEL-Barometer: See *Barometer*.

WHEEL-Fire, is the same with what the Chymists call *Ignis Rotæ*; that is, a Fire which covers the Crucible, Copple, or Melting-pot, entirely over, at Top as well as round the Sides.

WHEEL, in the Art Military, is the Word of Command, when a Battalion is to alter its Front, either one way or other. If the Battalion is to wheel to the Right, the Man in the right Angle turns very slowly, and every one else moves and wheels from the Left to the Right, regarding him as the Centre; and, *vice versa*, when they are to wheel to the Left. When a Division of Men are on a March, if the Word be *Wheel to the Right*, or to the Left, then the Right or Left-hand Man keeps his Ground, turning only on his Heel, and the rest of the Rank move about quick, 'till they make an even Line with the said Right or Left-hand Man. Squadrons of Horse wheel much after the same manner.

WHELPS; so the Seamen called those Brackets which are set up on the Capstan, close under the Bars, and they give the Sweep to it, and are so contrived, that the Cable winding about them, may not surge so much as it would do, if the Body of the Capstan were quite round and smooth.

WHERLICOTS, were the open Chariots used here in England by Persons of Quality, before the Use of Coaches. See *Stow's Survey of London*, p. 70. Perhaps hence comes our Word *Whirligig*.

WHIP, or *Whip-staff*, in a Ship, is a Piece of Wood fastned into the Helm, for him that steers to hold in his Hand, whereby to move the Helm, and steer the Ship. It goes through the Rowl, and is made fast to the Tiller with a Ring. But this is not used in great Ships.

WHITE, or *Flame* Heat, is a Degree of Heat given by Smiths to their Iron in the Forge, when it hath not yet its Form and Size, but must be forged into both; this is a less Heat than a *Welding Heat*: Iron in this Heat is batter'd or drawn out usually with the Pen or Edge of the Hammer; and afterwards hath the Dents of the Pen smoothed out with the Face of the Hand-hammer.

WHITE-



WHITE-LEAD, how made: See *Ceruse*.

WHITENESS: This Colour, Mr. *Boyle* thinks, doth chiefly depend upon this, That the Surfaces of white Bodies are separated into innumerable small Planes or Superficies, which being of a Nature nearly specular, are also so placed, that some looking one way, and some another, do reflect the Rays of Light falling upon them, not towards one another, but outwards, towards the Spectator's Eye. But the Account of Whiteness, according to the *Newtonian* Hypothesis of Light and Colours, is, that 'tis the Result of the Mixture of all sorts of Rays of Light together: See *Colours* and *Light*.

WHITENESS. The excellent Sir *Isaac Newton*, in his late Book of Opticks, demonstrates, that Whiteness is a dissimilar Mixture of all Colours, and that the common Light of the Sun is a Mixture of Rays, endued with all those Colours; for by the multitude of those Rings of Colours which appear in the Compression of the two Prisms or Object-glasses of Telescopes together (see *Observ.* 3, 12, 24. Book 2. Part 1.) it is manifest, that these do so interfere and mingle with one another at last, as after 8 or 9 Revolutions, to dilate one another wholly, and constitute an even and sensibly uniform Whiteness. Wherefore it appears from hence, as well as from other Experiments, mentioned elsewhere, that Whiteness is certainly a Mixture of all Colours, and that the Light which conveys it to the Eye, is a Mixture of Rays indued with all those Colours. And he shews that Whiteness, if it be most strong and luminous, is to be reckoned of the *first Order* of Colours; but if less, to be a Mixture of the Colours of several Orders: Of the former sort he reckons white Metals; and of the latter, the Whiteness of Froth, Paper, Linen, and most other white Substances. And as the White of the first Order is the strongest that can be made by Plates of transparent Substances, so it ought to be stronger in the Substances of Metals than in the rarer ones of Air, Water, and Glass. Gold or Copper, mixed either by Fusion or Amalgamation with a very little *Mercury*, with Silver, Tin, or Regulus of Antimony, becomes *White*; which shews both that the Particles of *white Metals* have much more Surface, and therefore are smaller than those of Gold or Copper; and also that they are so opaque, as not to suffer the Particles of Gold or Copper to shine through them: And as he doubts not but that the Colours of Gold and Copper are of the second or third Order, therefore the Particles of white Metals can't be much bigger than is requisite to make them reflect the White of the first Order: And this he concludes also from other Observations and Experiments.

WHITE-Hart Silver, is a Mulct paid into the *Exchequer*, out of certain Lands, in or near the Forest of *White-Hart*; and it hath continued ever since *Henry the Third's* Time, who imposed it upon *Thomas de Lynde*, for killing a most beautiful *White-Hart*, which the King had before purposely spare'd in Hunting. *Camd. Brit.*

WHITSON *Farthings*. See *Pentecostals*.

WIDOW of the King, was she who after her Husband's Death, being the King's Tenant in *Capite*, was forced to recover her Dower by the Writ *de Dote assignanda*, and could not marry again without the King's Consent.

WILL. See *Testament*.

VOL. II.

WINDAGE of a Gun, if the Difference between the Diameter of the Bore, and the Diameter of the Balls.

WHOODINGS, in a Ship, are those Planks which are joined and fastned along the Ship's Side into the Stern.

WILL, or Last Will. See *Testament*.

WIND at Sea; they call bringing a Ship's Head about, *Winding of her*; and when she comes to ride at Anchor, she is said to *Wind up*: Also when she is under Sail, they use to require, *How she Winds*, i. e. which way she lies with her Head? So, to *Wind the Boat*, is to turn her Head about.

WIND is defined to be the Stream, or Current of the Air; and where such Current is perpetual and fixed in its Course, 'tis necessary that it proceed from a permanent unintermitting Cause. Wherefore some have been inclined to propose the diurnal Rotation of the Earth upon its Axis, by which as the Globe turns Eastward, the loose and fluid Particles of the Air, being so exceeding light as they be, are left behind; so that in respect of the Earth's Surface, that moves Westward, and becomes a constant Easterly Wind. This Opinion seems confirmed, for that these Winds are found only near the *Equinoctial*, in those Parallels of Latitude, where the diurnal Motion is swiftest; but the constant Calms in the *Atlantick Sea*, near the *Equator*, the Westerly Winds near the Coast of *Guinea*, and the periodical Westerly *Monsoons* under the *Equator* in the *Indian Seas*, seemingly declared the Insufficiency of that Hypothesis.

Besides, the Air being kept to the Earth by the Principle of *Gravity*, would in time acquire the same Degree of Velocity that the Earth's Surface moves with, as well in respect of the diurnal Rotation, as of the Annual about the Sun, which is about 30 times swifter.

It remains therefore to substitute some other Cause, capable of producing a like constant Effect, not liable to the same Objections, but agreeable to the known Properties of the Elements of Air and Water, and the Laws of the Motion of Fluid Bodies: Such an one is the Action of the Sun's Beams upon the Air and Water, as he passes every Day over the Oceans, considered together with the Nature of the Soil, and Situation of the adjoining Continents.

Therefore, according to the Laws of *Statics*, the Air, which is less rarified or expanded by Heat, and consequently more ponderous, must have a Motion round those Parts thereof, which are more rarified, and less ponderous, to bring it to an *Equilibrium*; also, the Presence of the Sun continually shifting to the Westward, that Part towards which the Air tends, by reason of the Rarefaction made by his greatest Meridian Heat, is with him carried Westward, and consequently the Tendency of the whole Body of the lower Air is that way.

Thus a general Easterly Wind is formed, which being impressed upon all the Air of a vast Ocean, the Parts impel one the other, and so keep moving 'till the next Return of the Sun, whereby so much of the Motion as was lost, is again restored, and thus the Easterly Wind is made perpetual.

From the same Principle it follows, that this Easterly Wind should on the North-side of the *Equator*, be to the Northwards of the East, and in South Latitudes to the Southwards thereof; for



near the Line, the Air is much more rarified than at a greater distance from it; because the Sun is twice in a Year vertical there, and at no time distant above 23 Degrees  $\frac{1}{2}$ ; at which Distance the Heat being at the *Sine of the Angle of Incidence*, is but little short of that of the perpendicular Ray. Whereas under the Tropicks, though the Sun stay long vertical, yet he is as long 47 Degrees off; which is a kind of Winter, wherein the Air so cools, as that the Summer Heat cannot warm it to the same Degree with that under the Equator. Wherefore the Air towards the Northward and Southward being less rarified than that in the middle, it follows, that from both sides it ought to tend towards the Equator. This Motion compounded with the former Easterly Wind, answers all the *Phænomena* of the general Trade-Winds; which, if the whole Surface of the Globe were Sea, would undoubtedly blow all round the World, as they are found to do in the *Atlantick* and *Æthiopic* Oceans.

But seeing that so great Continents do interpose and break the Continuity of the Oceans, regard must be had to the Nature of the Soil, and the Position of the high Mountains, which are the two principal Causes of the several Variations of the Wind from the former general Rule; for if a Country lying near the Sun, prove to be flat, sandy, and low Land, such as the Deserts of *Libya* are usually reported to be, the Heat occasioned by the Reflexion of the Sun's Beams, and the Retention thereof in the Sands, is incredible to those that have not felt it; whereby the Air being exceedingly rarified, it is necessary that this cooler and more dense Air should run thitherwards to restore the *Æquilibrium*: This is supposed to be the Cause why near the Coast of *Guinea* the Wind always sets in upon the Land, blowing Westerly instead of Easterly, there being sufficient Reason to believe that the inland Parts of *Africa* are prodigiously hot, since the Northern Borders thereof were so intemperate, as to give the Ancients cause to conclude, That all beyond the Tropicks was made uninhabitable by Excess of Heat.

From the same Cause it happens that there are so constant Calms in that part of the Ocean, called the *Rains*; for this Tract being placed in the middle, between the Westerly Winds blowing on the Coast of *Guinea*, and the Easterly Trade-Winds blowing to the Westwards thereof, the Tendency of the Air here is indifferent to either, and so stands in *Æquilibrio* between both; and the Weight of the incumbent Atmosphere being diminished by the continual contrary Winds blowing from hence, is the Reason that the Air here holds not the copious Vapour it receives, but lets it fall in so frequent Rains.

But as the cool and dense Air, by reason of its greater Gravity, presses upon the hot and rarified, 'tis demonstrative, that this latter must ascend in a continued Stream as fast as it rarifies; and that being ascended, it must disperse itself to preserve the *Æquilibrium*; that is, by a contrary Current the upper Air must move from those Parts where the greatest Heat is; so by a kind of Circulation, the North-East Trade-Wind below and the South-easterly and North-west Wind will be attended with a South-westerly above. That this is more than a bare Conjecture, the almost instantaneous Change of the Wind to

the opposite Point, which is frequently found in passing the Limits of the Trade-Winds, seems to assure us; but that which above all confirms this Hypothesis, is the *Phænomenon* of the *Monsoons*, by this means most easily solved, and without it hardly explicable.

Supposing therefore such a Circulation as above, 'tis to be considered, that to the Northward of the *Indian* Ocean there is every where Land within the usual Limits of the Latitude of 30, viz. *Arabia, Persia, India, &c.* which for the same Reason as the *Mediterranean* Parts of *Africa* are subject to unsufferable Heats when the Sun is to the North, passing nearly vertical, but yet are temperate enough when the Sun is removed towards the other Tropick, because of a Ridge of Mountains at some distance within the Land, said to be frequently in Winter covered with Snow, over which the Air as it passes must needs be much chilled.

Hence it comes to pass, that the Air coming according to the general Rule out of the North-East in the *Indian Sea*, is sometimes hotter, sometimes colder, than that which by this Circulation is returned out of the South-west, and by consequence sometimes the under Current, or Wind, is from the North-East, sometimes from the South-West.

That this has no other Cause, is clear from the Times wherein these Winds set in, viz. in *April*, when the Sun begins to warm those Countries to the North, the South-west *Monsoons* begin, and blow during the Heats 'till *October*; when the Sun being retired, and all things growing cooler Northward, and the Heat increasing to the South, the North-East enter and blow all the Winter 'till *April* again: And it is undoubtedly from the same Principle that to the Southward of the *Equator*, in part of the *Indian* Ocean, the North-West Winds succeed the South-East, when the Sun draws near the Tropick of *Capricorn*.

But in this latter occurs a Difficulty, not well to be accounted for, which is, why this Change of the *Monsoons* should be any more in this Ocean than in the same Latitudes in the *Æthiopic*, where there is nothing more certain than a South-East Wind all the Year.

'Tis likewise very hard to conceive why the Limits of the Trade-Wind should be fixed about the thirtieth Degree of Latitude all round the Globe; and that they should so seldom transgress or fall short of those Bounds; as also that in the *Indian* Sea, only the Northern Part should be subject to the changeable *Monsoons*, and in the Southern there should be a constant South-East.

This Account of Wind is from the learned Captain *Halley's* Discourse on this Subject. *Philosoph. Transf.* N° 183.

WIND. The late Reverend Mr. *Derham*, of *Upminster* in *Essex*, and F. R. S. in a curious and accurate Discourse about the Motion of Sound, in *Philosoph. Transf.* N° 313. takes occasion to say something of the Velocity of the Motion of Wind: And by many Trials he found, that the Wind in the greatest Storm doth not move above 50 or 60 *English* Miles in an Hour: That a common brisk Wind moves about 15 Miles in an Hour: But that the Course of many is so gentle, as not to exceed, if they come up to, one Mile in an Hour.

WIND-



**WIND-GUN.** Of this Instrument there are several Descriptions extant, but the following of Mr. *Papin's* is in all respects the best. (See Continuation of Mr. *Boyle's Physico-Mechanical Experiments*. Part 2. Iconism. 2. Fig. 4.)

A A is a Copper Globe, hollow within; B B is a Tube, fastned to that Globe. F is a Valve opening inwardly, and shutting the Globe B B; G is the Spring depressing the foresaid Valve. H is a Gnomon affixed to the Globe A A, and making fast the Spring G.

C C is a Tube of Iron, fastned to the Tube B B, and the Globe A A DD is a Plug exactly adapted to the aforesaid Tube. E E E is another Plug, fitted also to the Tube B B with an Iron Wire, reaching almost to the Valve F. R is the Protuberance of the Tube C C, somewhat hollowed above to receive the End of the Iron L L; and L L is a crooked Iron, moving about the Extremity in R, so that it is like a Leaver to lift up the Plug E E E. O P O is a crooked Iron, fastned in M, that the Thumb sticking in the Angle P, the rest of the Fingers may attract the Leaver L, and so force the Plug E E E upwards. But the Use of the Curvature is, that the one End O might be applied to the Shoulder, if it be thought fit to aim at any Mark.

T T is a Rectangle of Iron, encompassing the Leaver L L, and the Iron O P O, to keep the Leaver in that Posture which the present Scheme holds forth; for otherwise the Plug E E E would be thrust out far away, whilst we intrude the Air into the Globe A A.

I I is an Elliptick Hole in the upper Part of the Globe very well shut with a Valve, opening inwardly, whose Use is to give liberty of Inspection and of amending what is amiss; for the Valve may be drawn through the Hole, by reason of its Elliptick Figure.

S S is a metalline Plate transversly placed above the Hole I I, and perforated to transmit the Screw V, by whose help the Valve shutting, the Hole I I is sustained, and is applied closely to the Hole.

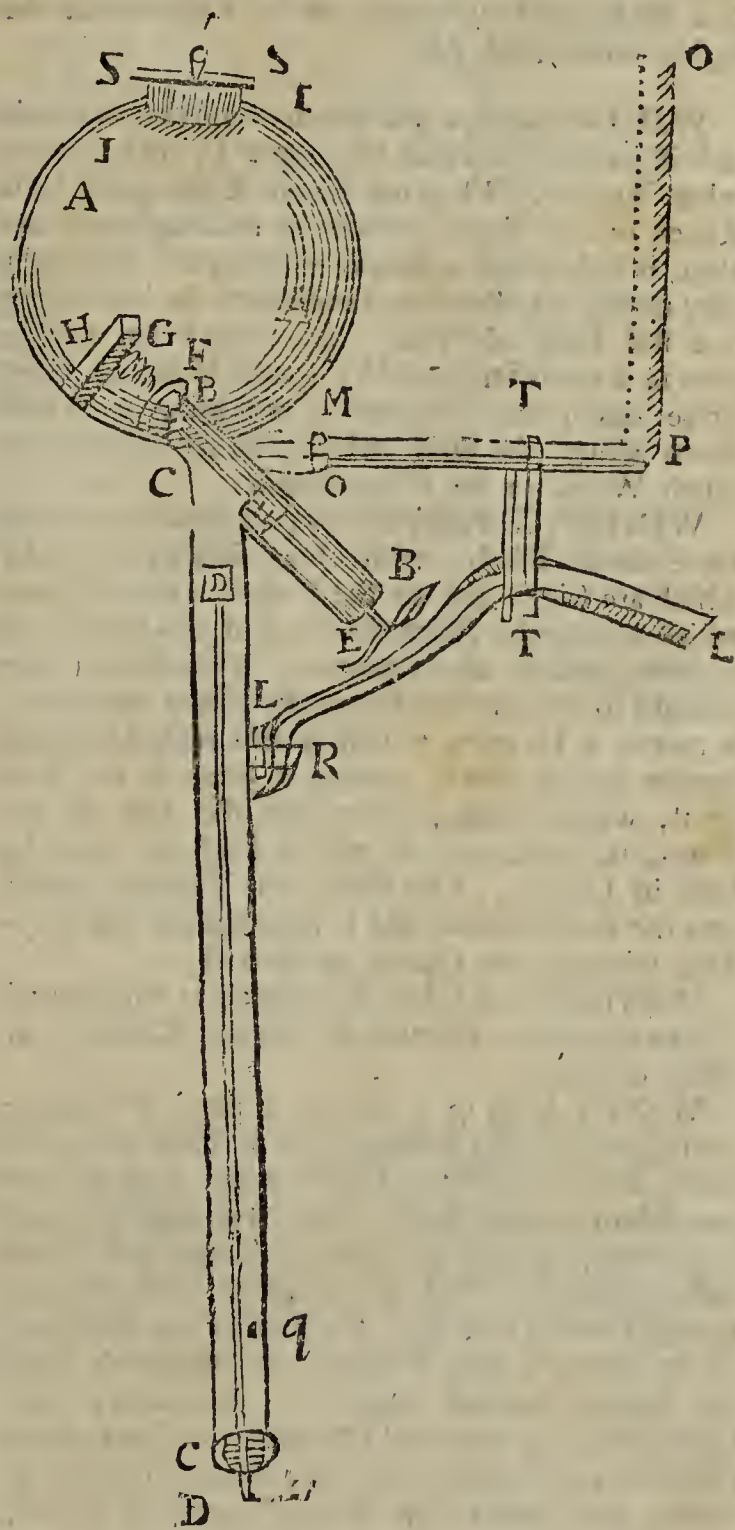
Q is an Hole in the inferior Part of the Tube C C, by which the Air enters into the Tube, whilst the Plug D D is brought to the lowest Part of the Tube.

The Air is thrust into the Engine after this manner: The crooked End of the Plug D D is pressed upon with the Foot, that it may not stir from the Ground; and the Engine being lifted upwards till the upper part of the Plug be found below the Hole Q; then the Air entring through the aforesaid Hole, doth wholly fill the Tube C C.

Then the Engine being forcibly depressed, the Air contain'd in the Tube C C opens the Valve F, and is thrust into the Globe A A; whence it cannot return, because the Valves presently stop the Passage; and thus by iterated Turns, we may condense the Air in the Globe, until the Force of its Spring cannot be overcome by our Strength.

Now to discharge the Air so condensed, the Plug D D is wholly to be drawn out, and a Bullet of Lead to be put into the bottom of the Tube C C; then by means of the Leaver L L L, the Plug E E E is to be impelled upward, as beforementioned, and then the Extremity of the Iron Wire opens the Valve B, and the Air breaking out therefrom, expels the Leaden Bullet through the Tube C C with great Violence.

*Note,* That before the Plug D D is again put into the Tube C C from the Compression of the Air, about half an Ounce of Water is to be poured into the foresaid Tube. For by this means no Air at all can escape out by the Plug; and moreover, that Water filling exactly the upper part of the Tube C C, will cause that the whole compressed Air will be intruded within the Cavity A A, and so the Condensation will be perfected much sooner than if at every Turn part of the compressed Air did remain below the Valve F. See the Figure following.



This Engine is much better than any Wind-Guns hitherto mention'd in Print.

1. Because that seeing one only Valve serves both for letting in, and discharging forth of the Air, it is less subject to be spoiled or impaired, than if two Valves were used for that Purpose.

2. If any Disorder happens in other Guns, the Engine remains useles; but here by the Elliptick Hole, a Man may take out the Spring and the Valve, and so mend whatsoever is amiss.



3. In other Guns, the Valves being cover'd with Leather, were put in before the Engine was on every Side shut; and therefore Silver Solder could not be used in cementing the Parts, but only Lead Solder; by which the Air, being much compress'd, could by no means be restrain'd: But here all Things are well cemented with Silver Solder, without Danger of Burning, in regard the Valve cover'd with Leather is put in afterward through the Elliptick Hole II.

4. But this Engine is chiefly to be preferred before others on this account, because we emit several Bodies into the Receiver through the Elliptick Hole, and so make many Experiments in highly compressed Air.

**WIND-Taught**, a Sea Term, implying as much as Stiff in the Wind; for they say a Thing is *Taught* when 'tis Stiff. Thus too much Rigging, all high Ropes, or any thing catching or holding the Wind aloft, is said to hold a Ship *Wind-taught*; by which they mean, that she stoops too much in her Sailing in a stiff Gale of Wind. So also, when a Ship rides in a main Stress of Wind and Weather, they strike down her Top-masts, and bring her Yards down along the Ship, which else would hold too much Wind, or be *Wind-taught*.

**WINDING Tackle-Blocks**; so the Seamen call those *double Blocks* with three *Shivers* in each, which are seized fast to the End of a small Cable which is brought about the Head of the Mast, and so serves instead of a Pendant. This hath a *Guy* brought to it from the Foremast. Into the Block is reeved a Hawser, which is also reeved through another double Block, having a Strap at the End of it, which being put through the Eye of the Slings, is lock'd into it with a *Fidd*, in order to hoise in Goods. The *Fall* of this Tackle is reeved into the *Snatch-Block*, and so is brought to the Capstan, whereby the Goods are heaved.

**WINDING-STAIRS**, are such as wind round a Newel, either Circular or Square, Close, *i. e.* *Solid*, or open.

**WINDLASS**, in a Ship, is a piece of Timber having six or eight Squares, and is fixed abaft the Stern aloft, where the Cables come in from the one Side of the Ship to the other, used now in small Ships only, and in the *Flemish* Ships, which are highly mann'd: But this *Windlass* will purchase more by much than any Capstan in the weighing of an Anchor, and without any Danger to those that heave, because they heave here about with Handspikes put into the Hole at either End of the *Windlass*; of which, tho' one should happen to break, yet would the *Windlass* paul of it self, without any farther Danger.

**WING**: The Romans called by the Name of *Alæ*, the *Wings*, two Bodies of Men in their Army, one on the Right, and the other on the Left, consisting each of 400 Horse, and 4200 Foot usually; and being wholly made up of Confederate Troops, these were designed to cover the Roman Army, as the Wings of a Bird cover its Body. The Troops in these Wings they call *Alares*, and *Alares Copiæ*; and we at this Day distinguish our Armies into the Main Body, the Right and Left Wings.

**WINGS**, in Fortification, are the large Sides of Horn-works, Crown-works, Tenailles, and the like Out-works; that is to say, the Ramparts and Parapets with which they are bounded on the

Right and Left, from their Gorge to their Front. These Wings or Sides are capable of being flank'd either with the Body of the Place, if they stand not too far distant; or with certain Redoubts, or with a Traverse made in their Ditch.



**WINGS**, in *Heraldry*, are borne without the Body of the Fowl, and sometimes single, and sometimes double; when they are double, they are called *Conjoined*; when the Tips are upwards they are called *Elevated*; when downwards, *Inverted*. See the Escutcheon.

**WINGED Seeds**, in *Botany*, are such as have Down or Hairs on them, by which the Wind taking hold, blows them to a Distance.

**WINGED Leaves**, in *Botany*, are such as consist of divers little Leaves, ranged in the same Direction, so as to seem but one and the same Leaf.

**WINTER Solstice**: See *Solstice*.

**WITHERNAM**, is the taking or driving of a Distress to the Hold, or out of the County, so that the Sheriff cannot upon Replevin make Delivery thereof to the Party distrained: In which Case, a Writ of *Withernam* is directed to the Sheriff, for the taking of as many of his Beasts that did thus unlawfully distrain, or as much Goods of his into his keeping, until he hath made Deliverance of the first Distress. Also, if the Beasts be in a Fortlet or Castle, the Sheriff may take with him the Power of the County, and beat down the Castle.

*Withernam*, in some Statutes, seems also to signify an unlawful Distress made by him that has no Right to distrain.

**WIT**. Mr. *Locke*, in his *Essay on Humane Understanding*, B. II. C. XI. Sect. 2. defines *Wit* (and thereby distinguishes it from *Judgment*) to be a quick and ready Assemblage of Ideas; and putting those together with great Facility and Variety in which can be found any Resemblance and Congruity, thereby to make up pleasant Pictures and agreeable Images in the Fancy. Hence it is that Metaphors and Allusions are so generally entertaining and pleasing; because their Beauty appears at first Sight, and there is required no Labour and Toil of Thought to examine what Truth or Reason there is in them.



**WIVERN**, in *Heraldry*, an Animal with Wings and Feet like a Bird, but the Tail, &c. like a Serpent, or a sort of flying Serpent, the upper Part resembling a Dragon, and the lower a Serpent.

**WOLD**, *Walda*, is a Down, or Champagne-Ground, Hilly, and void of Wood; as *Stow in the Wold*, and *Cotswold* in *Gloucestershire*.

**WOOD and Wood**, a Sea Term of two pieces of Timber being so let into each other, that the Wood of one joins close to the other.

**WORD**, in an Army or Garrison, is some peculiar Word or Sentence by which the Soldiers know and distinguish one another in the Night, &c. and by which Spies and treacherous Persons are discovered. 'Tis used also to prevent Surprizes. It is given out in an Army every Night by the General to the Lieutenant or Major-General of the Day, who gives it to the Majors of the



the Brigades, and they to the Adjutants, who give it first to the Field-Officers, and afterwards to a Serjeant of each Company, who carry it to the *Subalterns*. In Garrisons 'tis given, after the Gate is shut, to the Town-Major, who gives it to the Adjutants, and they to the Serjeants.

**WORM**; is that winding long Pewter Pipe which Apothecaries and Distillers place in a Tub of Water, to cool and condense the Vapours in Distillations of Spirits. Formerly, and sometimes now, this Worm, or something like it, was placed above the Head of the Still, and then a Refrigeratory at the upper End of it, which is very good to distil Spirit of Wine, and such fine Spirits. This the Chymists call a Serpentine.

**WORMING**, at Sea, is laying all along a small Line or Rope betwixt the Shrouds of any Cable or Hawser, in order to strengthen it; or, as the Seamen call it, *Succour it*.

**WOULDING**, on Board a Ship, signifies the winding of Ropes fast about a Yard or Mast that is *fished* (as they call it) in order to make it hold the better.

**WREATH**, in *Heraldry*, signifies a Roll of fine Linnen or Silk (like that of a Turkish Turbant) consisting of the Colours born in the Escutcheon, which in an Atchievement is placed between the Helmet and the Crest, and which doth immediately support the Crest.

**WRECK**, is where a Ship has perished on the Sea, and no Man escapes alive out of it. The Civilians term it *Naufragium*. This *Wreck* being made, the Goods that were in the Ship brought to Land by the Waves, belong to the King, or whom he assigns it to. But if a Man, or a Dog,

or a Cat escape alive, and that the Party to whom the Goods belong, come within a Year and a Day, and prove the Goods to be his, he shall have them again, by the Provision of the Statute of *Westm.* 1. cap. 4.

**WRIGHT's Sailing**. See *Mercator's Sailing*.

**WRIT Breve**, is the King's Precept, whereby any Thing is commanded to be done touching a Suit or Action: As the Defendant or Tenant to be summoned, a Distress to be taken, a Disseisin to be redressed, &c. And these *Writs* are diversly divided in divers respects; some in respect of their Order or Manner of granting, are called

**WRITS Original**, which are sent out for the summoning of the Defendant in a personal, or the Tenant in a real Action, before the Suits begin; or rather indeed to begin the Suit.

**WRITS Judicial**, are such as are sent out by Order of that Court where the Cause depends, on Occasion after the Suit is begun. And these are distinguished from the *Original Writs* thus: The *Teste* of the *Judicial Writ* bears the Name of the Chief-Justice of that Court whence it issues; whereas in the *Teste* of the *Original Writ*, the King's Name is inserted. Again, also, there are

**WRITS Personal and Real, Writs of Entry, Writs of Right, Writs of Privilege, &c.** of which see the *New Book of Entries*.

**WRIT of Rebellion**. See *Commission of Rebellion*.

**WRIT of Assistance**, issues out of the *Exchequer* to authorize any Person to take a Constable or other Publick Officer, to seize Goods or Merchandise uncustomed or prohibited. There is also a *Writ* of Assistance, which issues out of the Chancery, to give a Possession,

## X I P

**XEROPHTHALMY**, [*ξηροφθαλμία* of *ξηρός*, Gr. Dry, and *ὀφθαλμός*, Gr. the Eye] a dry *Ophthalmia*, or Blood-shot of the Eyes, without Weeping, which happens usually in dry Weather. *Blanchard*.

**XIPHIAS**, [*ἰφίας*, Gr.] according to some, is a sort of Comet, shaped like a Sword; the Head being like the Hilt, and the Tail streight and point-

ed, yet sometimes bending like a Cymiter, but when it is of a lesser, and of a more contracted Form, 'tis like a Knife, or Dagger.

**XIPHOIDES**, [*ἰφοειδής*, Gr.] is a pointed Cartilage of the Breast, called *Cartilago Ensisformis*.

**XYSTER**, [*ξύστρον*, Gr.] a Surgeon's Instrument to shave and scrape Bones with.

## X Y S



## Y A W

**YARD**, in *Anatomy*, the virile Member or *Penis*, which serves for the Evacuation of the Urine and Seed.

**YARD**, a long Measure, for measuring Cloth, Silk, &c. containing 3 Foot, or 36 Inches; this Measure was settled first by King *Henry I.* by the Length of his own Arm.

**YARDS** of a Ship, are those long pieces of Timber which are made a little tapering at each End, and are fitted each to its proper Mast to carry the Sails which are fastned to these Yards at their Head, and are hoisted up and let down together with the Yards by the Halliards.

For the Proportions of the Yards of a Ship, they commonly allow  $\frac{1}{2}$  of the Length of her Keel, or  $\frac{2}{3}$  of the Length of her Main-mast, for the Length of her Main-yards; and for the Thickness of them, they allow  $\frac{1}{4}$  of an Inch for every Yard in Length; the Top-yard is  $\frac{2}{3}$  of the Main-yard, and the Fore-yard is  $\frac{1}{2}$  of the Main-yard, or as some say  $\frac{2}{3}$ : The Spritsail-yard and Cross-jack, are of the same Length, viz.  $\frac{1}{2}$  the Mizzen-yard; and the Thickness of the Mizzen-yard and Spritsail-yard is  $\frac{1}{2}$  Inch to a Yard in Length.

All small Yards are half the great Yards from Cleat to Cleat: When a great Yard is down a *Portlast*, it gives the Length of all Topfail-sheets, Lifts and Ties, Jeers and Bunt-lines; as also of the Leech-lines and Halliards, measuring from the Hounds to the Deck: And when it is hoisted, it gives the Length of Clew-lines, Braces, Clew-garnets, Tackles, Sheets and Bow-lines.

The Terms belonging to the Yards, are, 1. *Top the Yards*; that is, make them hang even. The Clew-lines do most properly Top the Main and Fore-yards; but when the Top-fails are stowed, then the Topfail-sheets will Top them. 2. *Brace the Yard*, i. e. Traverse aft the Yard-Arm, whose Brace is haled. So that *Traverse the Yard*, is the same as to say, *Brace it aft*. 3. *Square the Yards*, i. e. see that they hang right across the Ship, and one Yard-Arm not traversed more than the other.

**YARD-Arm**, in a Ship, is that half of the Yard that is on either Side the Mast, when it lies athwart the Ship.

**YARD-LAND**, *Virgata Terra*, is a Quantity of Land, various according to the Place: At *Wimbledon* in *Surrey* 'tis accounted fifteen Acres; in other Countries 'tis twenty; in some twenty-four, some thirty, and in others even four Acres. This uncertain Quantity in 28 *Eliz.* 1. is called a *Verge of Land*.

**YARE**, is the Sea Word for Nimble, Ready, Quick, or Expeditious.

**YATCHES**, are Vessels with one Deck, carrying from 4 to 12 Guns, with from 20 to 40 Men; and are of Burden from 30 to 160 Tun. They draw little Water, and are used for running, and making short Trips, &c. They are of several Makes and Forms.

**YAWES**. At Sea, they say a Ship makes *Yawes*, when through the Fault of him at Helm she is not kept *steady* in her Course, but makes Angles in and out; to prevent which, the Conner cries, *Steady, Steady*, keep her Thus, Thus.

## Y E A

**YEAR**: The Time the Sun takes to go through the twelve Signs of the Zodiack. This is properly the Natural or Tropical Year, and contains 365 Days, 5 Hours, and 12 Minutes.

The *Sydereal Year*, is that Time in which the Sun departing from any fixed Star, comes to it again; and that is in 365 Days, 6 Hours, and almost 10 Minutes. But according to Sir *Isaac Newton's* New Theory of the Moon, the *Sydereal Year* is 365 D. 6 H. 9' 14"; and the *Tropical*, 365 D. 5 H. 48' 57".

The *Civil Year*, which is commonly used by all Nations, is very various, both as to its Beginning, and also as to its Length, according as they follow the Course of the Sun, Moon, or both.

The *Civil Lunar Year* contains 12 Lunations or Synodical Months, and contains but 354 Days: This being 11 Days less than the Solar Year, its Head in about 33 Years will run through all the Months and Seasons of the Year. This kind of Year is now used by the *Turks*, and seems to have had its first Rise in Countries where the Difference between Summer and Winter is not so sensible as it is with us; and where, for want of Astronomy, they know not how to estimate the Solar Year, and therefore began their Account of Months from the Phases of the Moon. And hence, as the learned Astronomer Dr. *Gregory* hints, it came to pass, that they began the Account of their Civil Day at Sun-set; for their Day must begin when their Month and Year did, and that was with the New Moon, which being to be determined by View, could not be discovered till after Sun-set.

The *Jews* had their *Secular Year*, which began at the Autumnal Equinox; and their *Sacred Year*, which began at the Vernal one.

The *Egyptians*, *Chaldeans* and *Affyrians*, first measured the Year by the Course of the Sun, which they suppose to contain but 360 Days; afterwards 5 more were added by *Mercury*, which he called *επαγόμενος*, i. e. *added*; but yet no notice was taken of the 6 Hours; by which means the *Egyptian Year* hath fixed no Place in reference to the true Solar Year; but anticipating a Day every four Years, runs quite round in 1460 Years.

This way of reckoning continued till *Egypt* becoming a Province of the *Roman Empire*, they took the *Julian Account*, only they kept the Names of their Months still, and order'd their matter so, that their *Thot*, the first Day of the Year, always happen'd on the 29th of *August* in the *Julian Year*. So that the *Egyptian* or *Coptick Year* is 4 Months and 3 Days before the *Roman Year*, which begins with the Calends of *January*.

The *Persians* account (according to the *Egyptian Way*) 365 Days.

The *Arabs*, *Saracens* and *Turks*, count their Year by the Motion of the Moon, and make it consist of 12 Moons or Months, whereof some have 30, and some 29 Days alternately; and these altogether make but 354 Days; so that their Month *Muharran*, in which they place the Beginning of the Year, in less than 34 Years will run quite round, and be in all Seasons. The *Arabs* indeed, by a Cycle of 30 Years, do remedy this by means of an *Intercalation* or *Embolism* of 11 Days.

The



The *Greeks* counted their Year by the Motion of both Sun and Moon, and finding that there was 11 Days difference between the Lunar and Solar Year, at first they added an Intercalary Month every two Years, containing 22 Days, which therefore they called *ἐμβολιαστὸν* the added or inserted Month. Afterwards considering the 6 Hours also, they put their *Embolism* off 'till 4 Years end; and then making the 3 first Years to contain 354 Days a-piece (which is the Lunar Year) this made the 4th Year to have 399 Days. And to make this *Intercalation* the more remarkable, they instituted the *Olympick Games* on every such 4th Year; whence came the Computation by *Olympiads*, each of which contained 4 Years.

Nevertheless they found that this would not do in process of Time; and therefore they first reduced the *Intercalation* to 8, and then to 11 Years; but still there was great Confusion, 'till one *Meton* a Citizen and famous Astronomer of *Athens*, thought of joining the two last Periods 8 and 11 together; which doing, he made a Period of 19 Years, in which the two Motions of the Sun and Moon are wholly accommodated, and the Moon changes on the same Day of the Month that she did 19 Years before. This Discovery, for its Fulness, was much celebrated, and the Number of the Period 19, the *Athenians* ordered to be set up in a publick Place, and to be written in Characters of Gold; whence it took the Name it still retains, being called the *Golden Number*.

The *Athenians* began their Year at the New Moon after the Summer Solstice, in their Month *Hecatombæon*, as *Plutarch* says.

There were also some Nations who made their Year to consist only of 4, or of but 3 Months, as *Macrobius* tells us in his *Saturnalia*, Lib. 1.

The *Carians* and *Acharnanians*, saith *Justin*, made their Year to consist of 6 Months, and reckoned but 15 Days to their Month.

The *Romans* had three sorts of Years: 1. That of *Romulus*, which contained but 10 Months; from whence the last Month of our Year retains the Name of *December*, as being the Tenth of his. This Year began in *March*. 2. *Numa Pompilius* his Year, which had *Romulus* his gross Mistake corrected, and two more Months added to it, viz. *January* and *February*; and then it contained only 355 Days, or 12 Lunar Months. 3. The Year of *Julius Cæsar*, who discovering that there were 10 Days more than *Numa* reckoned, made the Year 365 Days: And reserving the 6 Hours 'till every fourth Year, they then made another Day, which was added before the sixth of the Calends of *March*; so that in this fourth Year they accounted the 6th of the Calends of *March* twice; *Bis sexto-calendas*, whence came the Word *Bissextile*, or Leap-year, as we call it; which hath 366 Days. This Account is now used in *England*, and is the *Julian* or *Old Stile*.

But because there was still found an Error in this Calculation, and that the *Equinoxes* did plainly, tho' insensibly recede from the Points where *Cæsar* had fixed them; as also, that the Year was discovered to want about 11 Minutes of 365 Days and 6 Hours; which 11 Minutes will in 131 Years make the *Equinoxes* go back about a Day; Pope *Gregory XIII.* to reform (as he thought) this Error, ordered 10 Days to be taken from the Year, to bring the *Equinoxes* that Year (which was 1582) to *March* 21, and *September* 22, 23. And this is

what is called the *Gregorian Account* or *New Stile*, as is used by the *Popish Nations* every where.

The *Great Year*, or the *Annus Magnus*, about 25000 or 26000 Years; in which Time the fixed Stars will appear to come to the same Point again, exactly after one entire Revolution.

A Year is a certain Space of Time, the Parts of which are commonly called Months, and is either *Astronomical* or *Civil*.

The *Astronomical Year* is also twofold, namely the *Syderial* and *Tropical*.

The *Syderial Year* is that Space of Time that the Sun having departed from a fix'd Star, returns to the same again; being 365 Days, 6 Hours and 10 Minutes nearly. The *Tropical Year*, is that wherein the Sun departing from one of the Cardinal Points, viz. the *Equinox* or the *Solstice*, returns to it again, and is something less than the *Syderial*, because the Cardinal Points of the *Ecliptick* themselves go backward about 50 Seconds of a Degree, as it were meeting the Sun, which makes the Sun return to the same Point of the *Ecliptick*, about 21 Minutes of the Time sooner than to the same fix'd Star, where that Point of the *Ecliptick* was when the Sun was before in the same Point: Therefore the *Tropical Year* consists of 365 Days, 5 Hours and 48  $\frac{1}{2}$  Minutes very near. But whereas the Hours and Minutes above the whole Days of a Solar Year cannot be taken notice of in civil or common Use: Therefore the *Civil* or *Solar Year* in use among us is made to consist only in 365 Days for 5 Years together, and every fourth Year of 366 Days, the Solar Year having 5 Hours 49  $\frac{1}{2}$  Minutes very near above the whole Days, there are added every Year about 11 Minutes to make 6 Hours, and these 6 Hours amount just to a whole Day in 4 Years.

The *Civil Lunar Year* consists of 12 Lunations or *Synodical Months*, which is finished in 354 Days, at the end of which the Year begins again. It has this Inconveniency, that the same Months in several Years have not the same Seasons; the occasion of which is, that the Lunar Year being less than the Solar by almost a 11 Days in three Years time, every Month will have the Season of that Month which went before it. Hence it is that the beginning of this Year falling upon the Spring now, in eight Years time would fall upon Winter, and eight Years after that would begin in *Autumn*, then in Summer: And, lastly, at the end of thirty-three Years return to Spring again, and thus is called the wandering Lunar Year, because its beginnings wanders thro' every Season of the Year. This Year is in use among the *Turks*; but the *Jews*, who follow the Moon's Motion in their Accounts, retain still the same Season in the same Months; for as often as there is the Difference of 30 Days between the common Lunar Year and the Solar Year, they intercalate a Month; by which means the Lunar and Solar Years are kept so adjusted the one to the other, that the Lunar Year will keep in a manner fix'd to the same Part of the Solar Year.

All Nations, before the just Length of the Solar Year was known, reckoned a Month by the Course of the Moon, and Years by the Return of Summer and Winter, Spring, and Autumn. And in making Calendars for their Festivals, they reckoned 30 Days to a Lunar Month, and 12 Lunar Months to a Year, taking the nearest round Numbers; whence came the Division of the *Ecliptick*

into



into 360 Degrees; so in the Times of *Noah's* Flood, when the Moon could not be seen, *Noah* reckoned 30 Days to a Month; but if the Moon appeared a Day or two before the Month was done, they began the next Month with the first Day of her appearing. And this was done generally 'till the *Egyptians* of *Thebais* found the Length of the Solar Year.

The ancient Calendar Year of the *Greeks* consisted of 12 Lunar Months, and every Month of 30 Days; and these Years and Months they corrected from Time to Time by the Courses of the Sun and Moon, omitting a Day or two in the Month, as often as they found the Month too long for the Course of the Moon, and adding a Month to the Year as often as they found the twelve Lunar Months too short for the Return of the four Seasons. *Cleobulus*, one of the seven Wise-men of *Greece*, alluded to this Year of the *Greeks*, in his Parable of one Father which had twelve Sons, each of which had 30 Daughters, half White and half Black. And *Thales* called the last Day of the Month, the Thirtieth, calling that Day, the Old and the New, or the last Day of the Old Month, and first of the New; for he introduced a Month of 29 Days and 30 alternately, making the Thirtieth Day of every other Month the first of the next Month.

To the twelve Lunar Months, the ancient *Greeks* added a Thirteenth every other Year, which made their *Dieteris*; and because this Reckoning made their Year too long by a Month, in eight Years they omitted one intercalary Month, which made their *Oetaeteris*, one half which was their *Tetraeteris*. And these Periods seem to have been almost as old as the Religion of *Greece*, being used in diverse of their *Sacra*. The *Oetaeteris* was the *Annus magnus* of *Cadmus* and *Minos*, and seems to have been brought into *Greece* and *Crete* by the *Phœnicians*, who came thither with *Cadmus* and *Europa*, and to have continued 'till after the Days of *Herodotus*. For in counting the Length of seventy Years, he reckons thirty Days to a Lunar Month, and 12 such Months or 360 Days to the ordinary Year, without the intercalary Months, and 25 such Months to be the *Dieteris*; and according to the Number of Days in the Calendar Year of the *Greeks*, *Demetrius Phalerius*, had 360 Statues erected to him by the *Athenians*, but the *Greeks*, *Cleostratus Herpalus* and others, to make their Months agree better with the Course of the Moon, in the Time of the *Persian* Empire varied the Manner of intercalating the three Months in the *Oetaeteris*; and *Meton* found out the Cycle of intercalating seven Months in 19 Years. The ancient Year of the *Latins* was also Luni-Solar; for *Plutarch* tells us, that the Year of *Numa* consisted of 12 Lunar Months, with an intercalary Month, to make up what the 12 Lunar Months wanted in the Solar Year. The ancient Year of the *Egyptians* was also Luni-Solar, and continued to be so 'till the Days of *Hyperion*, or *Osiris*, a King of *Egypt*, the Father of *Helius* and *Selene*; for the *Israelites* brought this Year out of *Egypt*: And *Diodorus* tells us, that *Ouranus*, the Father of *Hyperion*, used this Year, and that in the Temple of *Osiris*, the Priests appointed thereunto, filled 360 Milk Bowls every Day, I think he means one Bowl every Day, in all 360, to count the Number of Days in the Calendar Year, and thereby to find out the Difference between this

and the true Solar Year, for the Year of 360 Days was the Year to the end of which they added the 5 Days. That the *Israelites* used the Luni-Solar Year; is beyond question: Their Months began with their New Moons: Their first Month was called *Abib*; from earing of Corn in that Month. Their Passover was kept upon the 14th Day of the first Month, the Moon being then in the Full; and if the Corn was not then ripe enough for offering the First-Fruits, the Festival was put off by adding one intercalary Month to the end of the Year; and the Harvest was got in before the Pentecost, and other Fruits gathered before the Feast of the seventh Month. *Simplicius* tells us, in his Commentary on the first of *Aristotle's Physical Acroasis*, that some begin the Year upon the Summer Solstice, as the People of *Attica*; or upon the Autumnal Equinox, as the People of *Asia*; or in Winter, as the *Romans*; or about the Vernal Equinox, as the *Arabians* and People of *Damascus*: And the Month began according to some upon the Full Moon, or upon the New. The Years of all these Nations were therefore Luni-Solar, and kept to the four Seasons; and the *Roman* Year began at first in Spring, as appears from the Names of their Months, *Quintilis*, *Sextilis*, *September*, *October*, *November*, *December*; and the beginning was afterwards removed to Winter. The ancient Civil Year of the *Affyrians* and *Babylonians*, was also Luni-Solar: For this Year was also used by the *Samaritans*, who came from several Parts of the *Affyrian* Empire. And the *Jews* who came from *Babylon* called the Months of their Luni-Solar Year after the Names of the Months of the *Babylonian* Year: And *Berosus* tells us, that the *Babylonians* celebrated the Feast *Sacæa*, upon the Sixteenth of the Month *Lous*, which was a Lunar Month of the *Macedonians*, and kept to one and the same Season of the Year: And the *Arabians*, a Nation who peopled *Babylon*, use Lunar Months to this Day: *Suidas* tells us, that the *Sarus* of the *Chaldeans* contains 222 Lunar Months, which are 18 Years, consisting each of 12 Lunar Months, besides Six intercalary Months. And when *Cyrus* cut out the River *Andre* into 360 Channels, he seems to have alluded to the Number of Days in the Calendar Year of the *Medes* and *Persians*. At length the *Egyptians*, for the sake of Navigation, applied themselves to observe the Stars, and by their Heliacal Risings and Settings, found the true Solar Year to be 5 Days longer than the Calendar Year, and therefore added 5 Days to the 12 Calendar Months, making the Solar Year to consist of 12 Months and 5 Days. *Strabo* and *Diodorus* ascribe this Invention to the *Egyptians* of *Thebes*. The *Theban* Priests, saith *Strabo*, are above others said to be Astronomers and Philosophers. They invented the reckoning of Days, not by the Course of the Moon, but by that of the Sun.

To 12 Months, each of 30 Days, they add yearly 5 Days. In memory of this Emendation of the Year, they dedicated the five additional Days to *Osiris*, *Isis*, *Orus*, senior, *Typhon*, and *Nephthe*, the Wife of *Typhon*, finding that those Days were added to the Year when those five Princes were born, that is, in the Reign of *Ouranus* or *Amnion* the Father of *Sesac*. And in the Sepulchre of *Amenophis*, who reigned soon after, they placed a golden Circle of 363 Cubits in compass, and divided it into 365 equal Parts, to represent all the Days



Days of the Year, and noted upon each Part the Heliacal Risings and Settings of the Stars on that Day; which Circle remained there 'till the Invasion of Egypt by *Cambyfes*, King of *Persia*. 'Till the Reign of *Ouranus*, Father of *Hyperion*, and Grandfather of *Heleus* and *Selene*, the *Egyptians* used the old Luni-Solar Year: But in his Reign, that is, in the Reign of *Ammon*, Father of *Osiris*, or *Sesac*, and Grandfather of *Orus* and *Bubaste*, the *Thebans* began to apply themselves to Navigation and Astronomy. And by the Heliacal Risings and Settings of the Stars, determined the Length of the Solar Year. And to the old Calendar Year added 5 Days, and dedicated them to his 5 Children above-mentioned, as their Birth-days. And in the Reign of *Amenophis*, when by further Observations they had sufficiently determined the Time of the Solstices, they might place the beginning of this New Year upon the Vernal Equinox. This Year being at last propagated into *Chaldea*, gave Occasion to the Year of *Nabonassar*; for the Years of *Nabonassar*, and those of *Egypt* began on one and the same Day, called by them *Thoth*, and were equal, and in all Respects the same. And the first Year of *Nabonassar* began on the 26 Day of *February* of the Old Roman Year, seven Hundred forty and seven Years before the Vulgar *Æra* of Christ.

The *Turks* and *Arabians* make use of the Lunar Year, somewhat adapted to civil Use; and the same Custom is also observed in *Tartary*, *Siam*, and *Japan*, and some other Places. Political or Civil Years are used in the Regulation of Civil or Ecclesiastick Affairs; and in adjusting their Measures, regard is had to the Motion of the Luminaries. There are several sorts of Civil Years, among which, that called the *Julian*, is the most celebrated. It derives its Name and Institution from *Julius Cæsar*. He observing the *Egyptian* Year to get before the Tropical, because the six Hours it wants of the Tropical are intirely neglected in its Constitution, did therefore add these six Hours to every *Julian* Year; so that a *Julian* Year consists of 365 Days, six Hours; and because the Quarter of a Day cannot be consider'd or taken notice of in civil Use, he ordered the six Hours to be neglected 'till they made a Day, which happening every fourth Year, was to be inserted, by way of Intercalation, between the 23d and 24th of *February*. Therefore from that Time they write the Sixth of the Calends of *March* twice, from which the Year had the Name of the *Bissextile*. And this *Julian* Year of 365, and every fourth Year of 366, is the best fitted for Astronomical Computations, because it is a Mean between the Natural and Tropical Year of 365 Days, 5 Hours, and 49 Minutes, and the Syderial Year 365 Days and 10 Minutes; and does as it were give an ocular Demonstration of the Equinoxes. But this *Julian* Year, the Quantity of it must be own'd to be too big, on which Account the beginning of this also, by little and little, crept forward with regard to the Seasons, or (which is all one) the Times of the Equinoxes and Solstices creep backward in regard of the Days of this Year. And since this Regress is about 10 $\frac{1}{2}$  Minutes every Year in about 133 Years, it will be about a Day; and, consequently, from the Year of Christ 325, wherein the Council of *Nice* was held, to the Year 1582, wherein Pope *Gregory* reformed the Calendar, this Regress amounted to 10 Days. Hence it came to pass, that whereas in the Time of the *Nicene* Council the Vernal Equinox happened near about the 21st of

*March*, in the Year 1582, it was found to be about the 11th of *March*. That Pope *Gregory* might therefore bring the Equinox to its former place, ten Days were suppressed in the Month of *October*, in the Year 1582; and the 5th Day was called 15th: by this means, what would other ways have been the 11th of *March* following, became the 21st of *March*; that is, the Equinox happened the same Day as it did in the Time of the Council of *Nice*. And that the like Variation might not happen again, the said Pope ordered that once in 133 Years, a Day should be taken out of the Calendar, or (which comes to the same) that three Days should be taken out of every 400 Years; and this he appointed to be done by making every hundredth Year of the Christian *Æra* common, which, according to the *Julian* Account, is always *Bissextile*; but every 400 Year to continue *Bissextile*, as in the *Julian* Account. This Form of the Year, settled by Pope *Gregory* XIII. was called from him the *Gregorian*, and is observed in *Italy*, *France*, *Spain*, *Germany*, and wheresoever the Authority of the Pope reaches.

As the Form of the Year among different Nations is various, so likewise is its Beginning. The *Jews* began their Ecclesiastical Year with the New Moon of that Month whose Full Moon happens next after the Vernal Equinox. The Church of *Rome* began their Year with the *Sunday* that happens next after the said Full Moon, or the Feast of the Resurrection of our Lord. The *Jews* begin their Civil Year with the New Moon that hath its Full Moon happening next after the Autumnal Equinox. The *Grecians* began their Year with the New Moon that happens next after the Summer Solstice. The *Romans* anciently began theirs with the New Moon that happens next after the Winter Solstice; and this seems to be the Reason why *Julius Cæsar* fixed the beginning of his Year to the Calends of *January*. The more celebrated Collections of Years or Times, measured by a Repetition of Years, are in an Olympiad of 4 Years, a Jubilee of 49 or 50 Years, and one *Annus Magnus*, or great Year, standing for one intire Revolution of the fix'd Stars, 'till after having departed from a fix'd Point, they return to the same again; which is 25000 or 26000 Years. And thus much for the several Parts into which Time is in general distinguished.

YEAR and Day, in Law, is a Time that determines a Right in many Cases; and in some Works an Usucaption, in others a Prescription; as in Case of an Estray, if the Owner (Proclamation being made) challenge it not within that Time, it is forfeit: So is the Year and Day given in case of Appeal, in case of Descent after Entry or Claim, and in case of a Man so bruised and wounded; of Protection, Essoigns in respect of the King's Service; of a Wreck, and divers other Cases. *Co. Vol. 6. Fol. 107.*

YEAR, Day and Waste, is a Part of the King's Prerogative, whereby he challengeth the Profits of their Lands and Tenements for a Year and a Day, that are attainted of Petty-Treason, or Felony, whoever is Lord of the Mannor whereto the Lands or Tenements belong; and not only so, but in the End may waste the Tenements, destroy the Houses, root up the Woods, Gardens, Pasture, and plow up the Meadows, except the Lord of the Soil agree with him for Redemption of such Waste, afterward restoring it to the Lord of the Fee.



Y L Y

YEARS-MIND, S *See Annuals.*

1. The first of these is the fact that the  
2. second of these is the fact that the  
3. third of these is the fact that the

YOIDES. See *Hyoide*.

YOKE: See *Sea-Yoke*.

YPSILOIDES, § [of  $\Upsilon$  or  $\Upsilon\psi\iota\lambda\omicron\varsigma$ , and

To receive the benefit of the law, it is necessary that the person who has been injured by the act of another should be able to prove that he was injured by such act.

Z O D

**ZENITH** [זֶנִּיט, *Arab. whence* מִנְהָגָה, *Heb.*] or Vertex, is the Point in the Heavens; right over one's Head, being necessarily 90 Degrees distant from the Horizon.

**ZENITH Distance**, is the Complement of the Sun, or Stars Meridian Altitude, or what the Meridian Altitude wants of 90 Degrees.

ZENSUS, in *Arithmetick*, a Name given by some Authors to a Square or Second Power, and the higher Powers they call *Zensizensus*, *Zensicubus*, *Zensiresenzses*, and *Zensurde solidus*, &c.

ZERNA: See *Lichen*.

**ZETETICK** [*of ζήτησις, Gr. to seek*] Method in Mathematicks, is the Analytick, or Algebraick way, whereby the Nature and Reason of the Thing is primarily investigated and discovered.

ZEUGMA, is a Figure in Grammar, when an Adjective or Verb, agreeing with a nearer Word, is also by way of Supplement referred to one more remote: Thus, saith Terence, *Utinam aut hic surdus, aut hæc muta facta sit.*

ZOCCO : See *Plinthus*.

**ZOCLE**, is a square Member in Architecture, being lower than its Breadth, which serves to support a Pillar, or any other part of a Building, instead of a Base, Plinth, or Pedestal.

*Continued Zocle*, is a kind of continued Pedestal, on which a Structure is raised, but hath no Base or Cornish.

**ZODIACK**, [*ζῳδιακός*, of *ζῷ*, because it was be-  
lieved to afford Life and Heat to Animals, or of *ζῷον*,  
*Gr.* living Creatures] is a great Circle of the  
Sphere, dividing it into two equal Parts, cutting  
the Equator in the East and West Points of the  
Horizon. It cuts the Horizon and Equinoctial  
obliquely; making with the former an Angle equal  
to the Sun's greatest Meridian Altitude in any Lati-  
tude; and with the Equinoctial, an Angle of  $23^{\circ}$ ,  
 $30$  Minutes, which is the Sun's greatest Declina-  
tion.

The *Zodiack*, in the *Globe*, is mark'd with the Characters of the Twelve Signs, and in it is found out the Sun's *Place*, which is *under what Star or Constellation* he appears to be at Noon.

By this are determined the four Quarters of the Year; and accordingly it is divided into 4 Parts, and as the Sun goes on here, he hath more or less Declination North and South.

Also from this Circle, the Latitudes of the Planets and fixed Stars are accounted from the Ecliptick towards its Poles.

And those Poles are 23 Degrees 30 Minutes distant from the *Poles of the World*, or of the *Equinoctial*; and by their Motions are the Polar Circles described.

In these Poles all the Circles of Longitude, which are drawn through the *Zodiack*, do terminate (as the Meridians and Hour-Circles do in the Poles of the World) and as the Azimuth-Circles do in the Zenith and Nadir.

The Breadth of this Circle, or rather Zone, in the Heavens, is 20 Degrees; for beyond 10 Degrees North, or 10 Degrees South, the Latitude of no Planet ever reaches.

It seems to have been divided into 12 Parts (which they call Signs) because while the Sun in a Year's time is running thro' the Zodiack or Ecliptick, there happen to be 12 Lunations; or the Moon undergoes all her Changes and Phases 12 times, pretty near. Each Sign is divided into 30 Degrees, so that the whole makes 360: And they begin to reckon at the Eastern Interfection of the Equinoctial and Ecliptick, or at the Vernal Equinox, where they place the first Point of *Aries*; going on thence to *Taurus*, *Gemini*, *Cancer*, &c. and when you count thus forward on, according to the usual Order and Course of the Signs, they call it, *in Consequentia*; but if you count backwards from *Taurus* to *Aries*, &c. they say, 'tis *in Antecedentia*.

The Reason of the Name of this Circle, and its Origin, was this.

The ancient Astronomers observed the Sun in his (apparent) annual Motion to describe always one and the same Line or Track in the Heavens, and never to deviate from this Path either to the North or the South, as all the other Planets, they found, did more or less. And because they observed the Sun to shift as it were backwards, through all the Parts of this Circle or Path, so that in his whole Year's



Year's Course he would Rise, Culminate, and Set with every Point of it, they distinguished the fixed Stars, which appeared in or near this Circle, into 12 Constellations or Divisions, which they called Signs, because they were Marks to distinguish whereabouts the Sun was. These Signs they painted usually in the Form of Animals, and thence came the word *Zodiack*; and the very middle Line of it is called the *Ecliptick*, because the Eclipses only happen when the Moon also is in that Line.

**ZODIACK** of the Comets. *Cassini* hath observed a certain Tract in the Heavens, within whose Bounds (by many Observations) he hath found most Comets, though not all, to keep. This he makes as broad as the other *Zodiack*, and marks it with Signs or Constellations like that; which are *Antinous*, *Pegasus*, *Andromeda*, *Taurus*, *Orion*, the lesser *Dog*, *Hydra*, the *Centaur*, *Scorpion*, and *Sagittary*.

**ZONE**, [*ζώνη*, Gr. a Girdle] in *Geometry*, is a Space contained between two Parallels; of these Zones there are five commonly reckoned, viz. two *Frozen*, two *Temperate*, and one *Burning Zone*.

The *Frozen Zones*, are those Parts of the Globe comprehended between the Pole and the Polar Circle; therefore one must be towards the North, the other towards the South: The *Frozen*, or *Frigid Zone*, towards the North, lying between the North Polar-Circle and the North Pole, contains part of *Iceland*, and *Norway*, *Lapland*, *Finmark*, *Samojeda*, *Nova-Zembla*, *Greenland*, and some other Parts of *North America*. The *Frigid Zone*, toward the South, lying between the South Polar-Circle and the South Pole, is it not yet known whether it contains Land or Water.

The *Temperate Zones*, are one on the North side of the Equator, between the Arctick-Circle, and the Tropick of *Cancer*; another on the South-side, between the Tropick of *Capricorn*, and the Antarctic Circle.

*Torrid Zone*, or *Burning Zone*, contains all that Space of Earth that lieth between the two Tropicks.

**ZOOLOGY** [*ζωολογία* of *ζωή*, Life, and *λόγος*, Gr. a Word] a Discourse or Treatise upon Animals or Living Creatures.

**ZOOGRAPHY** [*ζωογραφία* of *ζωή* Animals, and *γραφία*, Gr. a Description] is a Description of the

Nature and Properties of Animal Bodies, such as Beasts, Birds, Fishes, Insects, &c.

**ZOOPHORICK Column**, in *Architecture*, a statuary Column, or one that bears or supports the Figure of an Animal, [called *ζῶον*, Gr. a living Creature.]

**ZOOPHORUS**, { in ancient *Architecture*,  
**ZOPHORUS**, { the same as Freeze in the Modern.

**ZOOPHYTE** [of *ζῶον*, an Animal, and *φυτὸν*, Gr. a Plant] the Animal Plant; a kind of intermediate Bodies, which partakes both of the Nature of an Animal and Plant, as the Sensitive Plant is supposed to be, but falsely.

**ZOOTOMY**, [*ζωτομία* of *ζῶον* and *τομή*, a Section of *τέμνω*, Gr. to cut] is an Artificial Dissection of Brute-Animals, as *Androtomy* is of the Bodies of Men.

**ZYGOMA** [*ζυγώμα*, Gr.] or *Os Mali*, is one of the Bones of the Upper Jaw; it is of a triangular Figure; on the upper Part it joins to the *Os Sphænoides*, on the lower to the *Os Maxillare*; its external part hath a long Process, called *Processus Zygomaticus*; it joins with the *Os Frontis*, at the Corner of the Eye.

**ZYGOMATICA**, are Muscles which draw both Lips obliquely to either side, and are otherwise called *Jugale*.

**ZYGOMATICUS**, is a Muscle of the Face, so called by *Riolan*, because it arises from the *Os Jugale*, or *Zygoma*. Its Origination is round and fleshy from the external Part of the said Bone; whence descending obliquely forwards, it is inserted near the Angle of the Lips; whence the Muscle and its Partner act: they draw both Lips upwards, and make a pleasant Countenance.

**ZYMOMA** [*ζύμωμα*, Gr.] is any Ferment, as the Nitrous Air, the Watry Juice in the Mouth, the Acid Liquor in the Stomach, the Blood in the Spleen, &c. *Blanchard*.

**ZYMOSIMETRE** [of *ζύμωσις*, Fermentation, and *μέτρον*, Gr. Measure] is an Instrument whereby the Degree of the Fermentation, arising from the mixture of divers Liquors, is measured; or the Temperament or Degree of Heat in the Blood of Animals, &c.

**ZYMOSIS**. See *Fermentation*.



















